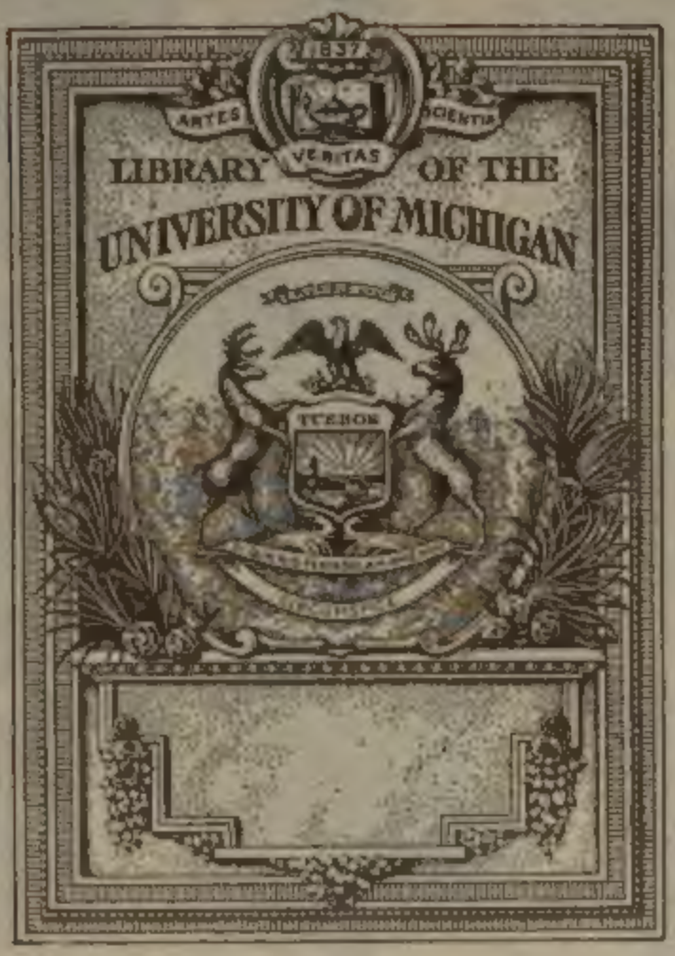


JOURNAL

OF THE

Royal United Service Institution,

WHITEHALL YARD.

PUBLISHED UNDER THE AUTHORITY OF THE COUNCIL.

VOL. VIII.

LONDON:
PUBLISHED BY W. MITCHELL AND SON,
39, CHARING CROSS,
NEAR THE ADMIRALTY AND HORSE GUARDS.
1865.

HARRISON AND SONS,] [ST. MARTIN'S LANE

ROYAL UNITED SERVICE INSTITUTION.

PATRON.

HER MAJESTY THE QUEEN.

VICE-PATRONS.

GENERAL H.R.H. THE PRINCE OF WALES, K.G., K.S.I., &c., &c.

FIELD-MARSHAL H.R.H. THE DUKE OF CAMBRIDGE, K.G., K.P., G.C.M G., &c., &c., COMMANDING-IN-CHIEF.

FIELD-MARSHAL HIS MAJESTY THE KING OF THE BELGIANS, K.G., &c., &c.

Palmerston, Right Hon. Viscount, K.G., G.C.B., M.P., First Lord of the Treasury.
Grey, Right Hon. Sir G., Bart., G.C.B., M.P., Secretary of State for the Home Department.
Russell, Right Hon. Earl, K.G., F.R.S., Secretary of State for Foreign Affairs.
Cardwell, Right Hon. E., Secretary of State for the Colonies.
De Grey and Ripon, Right Hon. Earl, Secretary of State for War.
Wood, Right Hon. Sir Charles, Bart., G C.B., M.P., Secretary of State for India.
Somerset, His Grace the Duke of, K.G., First Lord of the Admiralty.
Wodehouse, Right Hon. Lord, Lord Lieutenant of Ireland.
Dalhousie, Right Hon. the Earl of, K.T., G.C.B.
Hardwicke, Admiral the Right Hon. the Earl of, F.R.S.
Broughton, Right Hon. Lord, G.C.B., F.R.S.
Baring, Right Hon. Sir Francis T., Bart., M.P., F.R.S.
Beresford, Right Hon. W., M.P.
Murchison, Sir Rod. Impey, K.C.B., G.C.St.S., F.R.S., &c.
Peel, Lieut.-General Right Hon. J., M.P.
Pakington, Right Hon. Sir John, Bart., G.C.B., M.P.
Austen, Sir Francis W., G.C.B., Admiral of the Fleet.
Parker, Sir William, Bart., G.C.B., Admiral of the Fleet.
Blakeney, Field-Marshal, Right Hon. Sir Edward, G.C.B., G.C.H., &c.
Gough, Field-Marshal, Viscount, K.P., G.C.B., K.S.I., &c.
Cochrane, Sir Thomas J., G.C.B., Vice-Admiral of the United Kingdom.
Seymour, Sir George F., G.C.B., G.C.H., Rear-Admiral of the United Kingdom.

PRESIDENT.—GENERAL LORD HOTHAM, M.P.

VICE-PRESIDENTS.

Smyth, W. H., Admiral, K.F.M., D.C.L., F.R.S., F.S.A., F.R.G.S., &c.
Fox, C. R., General.
Stanhope, P. Spencer, Lieut.-General.
Back, Sir George, Vice-Admiral, D.C.L., F.R.S., &c.
Yorke, P. J., Col. late Scots Fusilier Guards, F.R.S.
Lindsay, Hon. James, Major-General, M.P.
Pollock, Sir G., Gen., R.A., Bengal, G.C.B., K.S.I.
Hamilton, F. W., Major-General, C.B., Vice-President, Council of Education.
Alcock, T. St. Leger, Lieut.-Col.-Commandant Royal E. Middlesex Militia.
White, Loraine, Major.
Sykes, W.H., Col. Ret. H.M. Bom. Army, F.R.S., M.P.
Fishbourne, E. G., Captain, R.N., C.B.

COUNCIL. 1865—1866.

CHAIRMAN—Lindsay, Hon. James, Major General, M.P.

VICE-CHAIRMAN—Hay, Sir John C.D., Bart., Capt R..N., M.P., F R S.

Lacon, W. Stirling, Esq., late H.C.S.
Tupper, A. C., Capt. late Royal Brecknock Militia.
Barrow, John, Esq., F.R.S., late Admiralty.
Watson, C. E., Lieut.-Col., Unattached.
Boileau, John Theophilus, Major-Gen. R.E., Bengal, F.R.S.
Fletcher, Henry C., Lieut.-Col. Scots Fusilier Gds.
Rumley, Randal, Major-General, Inspector-Gen. of Infantry.
Egerton, Charles R., Captain R.N.
Collinson, R., Rear-Admiral, C.B.
Jefferson, R., Capt. h. p Ceylon Rifles.
Adair, R. A. Shafto, Col. Suffolk Mil. Art., F.R.S., A.D.C. to the Queen.
Nicolson, Sir F. E., Bart., Rear-Admiral, C.B.
Wellesley, G. G , Rear-Admiral, C.B.
Scott, Sir Sibbald D., Bart.
Maude, G. A., Lieut-Colonel, C.B., Crown Equerry.
Heath, Leopold G., Capt. R.N., C.B.
Packe, E., Captain late Royal Horse Guards.
Tyler, H. W., Captain R.E., Railway Dept., Board of Trade.
Hay, Sir John C. D., Bart., Capt. R.N., M.P.
*Cooke, A. C., Major R.E., Topographical Staff.
Le Couteur, J. H., Lt. Col. Coldstream Guards.
Hall, R., Capt. R.N., Private Secretary to First Lord of Admiralty.
Higgins, W. F., Esq., late Colonial Office.
Fanshawe, E. G., Rear Admiral

* Nominated by the War Office.

SECRETARY AND CURATOR—Captain Boughey Burgess.

ACCOUNTANT—Mr. George Felstead.

The following Officers have kindly consented to become Corresponding Members of Council:—

ROYAL NAVY.

Armistead, The Rev. C. J., M.A., Chaplain H.M. Ship Pembroke
Balfour, C. James, Comr. H.M. Ship Winchester
Balfour, C. Jno., Comr.
Bell, W. H., Asst.-Surgeon H.M. Ship Cossack
Bosanquet, G. S., Comr.
Codrington, W., Lieut. H.M. Ship Victoria
Colomb, P. H., Comr. H.M. Ship Edgar
Coote, R., Capt. H.M. Ship Gibraltar
Crauford, F. A. B., Capt., H.M. Ship Egmont
Crofton, S. S. L., Capt. H.M. Ship Satellite
De Horsey, A. F., Capt. H.M. Ship Wolverene
De Robeck, H. St. J., Lieut. H.M. Ship Revenge
Dickson, J. B., Capt. H.M. Ship Irresistible
Egerton, Hon. F., Capt.
Egerton, F. W., Lieut. H.M. Ship Stromboli
Ellis, J. H., Chief Engineer H.M. Ship Constance
Farquhar, A., Capt. H.M. Ship Lion
Field, E., Comr. H.M. Ship Dædalus
Fitzclarence, Hon. G., Comr.
Fulford, J., Capt. H.M. Ship Formidable
Gibbons, C., Comr. Coast Guard, Wexford
Harvey, T., Capt., H.M. Ship Leander
Hayes, J. M., Capt. H.M. Ship Tartar
Hutton, F., Rear-Admiral
Jones, O. J., Capt. H.M. Ship Shannon
Kerr, Lord, F. H., Capt. H.M. Ship Black Prince
Key, Astley Cooper, Capt. C.B., H.M. Ship Excellent
Kingston, A. J., Comr.
Lambert, R., Capt. H.M. Ship Liverpool
Lenon, John F., Lieut., H.M. Ship Wasp
Mayne, R. C., Capt.
Noddall, C. T. A., Comr. Dockyard, Deptford
Nolloth, M. S., Capt. H.M. Ship Princess Charlotte
Ommanney, E., Rear-Admiral
Parry, C., Comr. H.M. Ship Aurora
Pike, J. W., Comr.
Pittman, F., Asst.-Paymr. H.M. Ship Indus
Phillimore, A., Capt. H.M. Ship Defence
Prevost, J. C., Capt. H.M. Ship Procris
Randolph, G. G., Capt. H.M. Ship Orlando
Sandys, H. S., Lieut. H.M. Ship Rattlesnake
Shanks, J. G., Lieut. R. M. L. I.
Shortland, P. F., Capt.
Smith, S. S., Lieut. H.M. Ship Pylades
Stirling, C., Capt.
Spratt, T. A. B., Capt. C.B.
Verney, Edmund Hope, Commdr. H.M. Ship Grappler
Ward, Thos. Le H., Comr. H.M. Ship Columbine
Willis, W. W. G. B., Lieut. Rl. Mar. Lt. Inf.

ARMY.

Williams, O. L. C., Capt. R.H. Grds.
Seymour, W. H., C.B., Col. 2nd Dr. Grds.
Swinfen, F. H., Major 5th Dr. Gds.
Sawyer, C., Col. 6th Dr. Gds.
Wardlaw, R., Col. 1st Royal Dgs.
Griffiths, H. D., C.B., Col. 2nd R. N. B. Dgs.
Bell, W. M., Major 3rd Hussars
Thesiger, Hon. C. W., Major 8th Inniskilling Dragoons
Trevelyan, H. A., Lieut.-Col. 7th Hus.
Baker, V., Lt.-Col. 10th Hussars
Harnett, E., Capt. 11th Hussars
Pole, E. A., Lieut. 12th Lancers
Maclean, FitzRoy D., Maj. 13th Hus.
Thompson, P. S., Lt.-Col. 14th Hus.
Abadie, H. R., Lieut. 17th Lanc.
Knox, R., Col. 18th Hussars
Maberly, E., Col. R.A., C.B.
Irving, A., Col. R.A., C.B.
Bayly, N. S. K., Capt. R.A.
Oldfield, R., Capt. R.A.
Stubbs, F.W., Capt. R.H.Art., Beng.
Collinson, T. B., Lieut.-Col. R.E.
Drake, J. M. C., Capt. R.E.
Molesworth, M. C., Capt. R.E.
Smith, G. P. L., Capt. R.E.
Earle, W., Lt.-Col. 1 Batt. Gren. Gds.
Stanley, Hon. F. A., Capt. 2 Batt. Gren. Guards
Johnstone, J. J., Capt. 3 Batt. Gr. Gds.
Seymour, W. F. E., Capt. 2 Batt. Colds. Gds.
Trefusis, Hon. W. R., Capt. 1 Batt. Scots Fus. Gds.
Monerieff, G. H., Lt.-Col. 2 Batt. Scots Fus. Gds.
Smith, J. W., Ens. 2 Batt. 1st Royals
Addison, T., C.B., Col. 1 Batt. 2nd Queen's Royals
Cowell, H.R., Capt. 2 Batt. 3rd Buffs
Martin, T., Maj. 1 Batt. 4th K.'s Own
Cocks, O.Y., Maj. 2 Batt. 4th K.'s Own
Bigge, T. S., Major 1 Batt. 5th Fus.
Kirkland, J. A. V., Col. 2 Batt. 5th Fusiliers
Lowe, E. W. D., C.B., Col. 1 Batt. 6th Foot
Kitchener, H., Lt. 2 Batt. 6th Regt.
Waller, G. H., Major 1 Batt. 7th Royal Fusiliers
Daubeny, A. G., Capt. 2 Batt. 7th Royal Fusiliers
Robertson, Alex. C., Col. 1 Batt. 8th King's
Brown, C. B., Lt. 2 Batt. 8th King's
Darling, S., Major 2 Batt. 9th Regt.
Bulger, G. E., Capt., 2nd Batt. 10th Regt.
Hare, E. H., Lieut. 2 Batt. 11th Regt.
Espinasse, J. W., Major 2 Batt. 12th Regt.
Cox, J. W., Col., C.B., 13th Lt. Inf.
Trevor, W. C., Lt.-Col. 2 Batt. 14th Regt.
Layard, C.E., Lieut. 2 Batt. 15th Regt.
Colthurst, D. L., Major 2 Batt. 17th Regt.
Pocklington, G. H., Capt. 1 Batt. 18th Royal Irish
Baker, T. B., Capt. 2 Batt. 18th Royal Irish
Warden, R., Col. 2 Batt. 19th Foot
O'Brien, J.T.N., Maj. 1 Batt. 20th Rgt.
Jones, E. M., Capt. 2 Batt. 20th Rgt.
Harding, F. P., C.B. Col. 1 Batt. 22nd Regt.
Swann, J. S., Capt. 2 Batt. 22nd Regt.
Torrens, H. D., Lieut.-Col. 1 Batt. 23rd R.W. Fus.
Armstrong, E., Capt. 2 Batt. 23rd R.W. Fus.
Plasket, W. A. H., Lieut. 1 Batt. 24th Regt.
Clark, T., Maj. 2nd Batt. 24th Regt.
Horne, E.G., Capt. 2nd Batt. 25th Reg.
Tupper, M. C. S., Capt. 29th Regt.
Collings, J. E., Col., 33rd Regt.
Chapman, A.T.L., Capt. 34th Regt.
Lloyd, T., Capt. 35th Regt.
Hort, J. J., Col. 36th Regt.
Grey, F. D., Lt.-Col. 37th Regt.
Elles, W. K., Capt. 38th Regt.
Leslie, A., C.B., Col. 40th Regt.
Bertram, C. P., Major 41st Regt.
Morgan, H., Capt. and Paym. 43rd Lt. Inf.
Parish, H. W., Major 45th Regt.
Lowry, R. W., Col. 47th Regt.
Adams, C., Col. 49th Regt.
Lock, A. C. K., Lt.-Col. 50th Regt.
Bellamy, P. L., Capt. 55th Regt.
Garsia, M. C., Lieut. 56th Regt.
Warre, H. J., C.B., Col. 57th Regt.
Lodder, W. W., Lt.-Col. 59th Regt.
North, C. N., Lt.-Col. 1st Batt. 60th Royal Rifles
Battersby, J. P., Capt. 3rd Batt. 60th Royal Rifles
Travers, F. S., Capt. 4th Batt. 60th Royal Rifles
Ingall, W. L., C.B., Col. 62nd Regt.
Barker, G. D., Major 64th Regt
Blewett, C., Capt. 65th Regt.
Yonge, G.N.K.A., Lt.-Col. 67th Rgt.
Mackirdy, D. E., Col. 69th Regt.
Gore, J. A., Major, 71st Highland Light Infantry.
Seaman, W C., M.D., Surg.-Maj. 72nd Highls.
Henslowe, S.V.F., Capt. 73rd Regt.
Malan, C. H., Capt. 75th Regt.
Hincks, A. S., Capt. 76th Regt.
Deverell, T. J., Col. 77th Regt.
Feilden, O. B., Capt. 78th Highrs.
East, C. J. Capt., 82nd Regt.
Atcherley, W. A., Lieut. 84th Regt.
Crosse, J. G., Major unattached
Haig, J. F., Lieut. 90th Lt. Inf.
Patterson, W. T. L., Lt.-Col. 91st Highlanders
Knollys, W. W., Capt. 93rd Highrs.
Cafe, H. L., Major, 94th Regt.
Thesiger, Hon. F.A., Col. 95th Regt
Kirk, J. B., Major 96th Regt.
Rainier, D., Col. 98th Regt.
Dunne, J. H., Major 99th Regt.
Salusbury, F. O., C.B., Lt.-Col. 101st Roy. Beng. Fus.
Clay, T.S., Capt. 103rd Roy. Bom. Fs.
Owen, G. A., Lieut. 107th Regt.
Maclean, H., Major 1 Batt. Rif. Brig.
Wood, H., Capt. 3rd Batt. Rif. Brig.
Doorly, M., Paym. 4th W. I. Regt.
Meuden, J., Capt. Ceylon Rifles
Pole, C. V. N., Major Cape M. Rif.
Grange, C. W., Maj. R. Can. Rifles
Hay, C. C., Maj. Gen. Comt. School of Musketry, Hythe
Walker, A., Lieut. 79th Highrs., School of Musketry, Fleetwood
Talbot, Hon. W. L. Major 4th Depot Batt. Colchester
Burney, H. S. S., Maj. & Paym. 6th Depot Batt., Walmer
McDonald, A. M., Col. 7th Depot Batt., Winchester

Nason, J., Lt.-Col. 12th Depot Batt., Athlone
Borton, A., C.B., Col. 17th Depot Batt., Limerick
Inglis, W., Col. 2nd Depot Batt., Chatham
Chichester, C. R., Maj. 13th Depot Batt., Fermoy
Hall, J. P., Major 14th Depot Batt., Cork
Brown, H. P., Lt.-Col. Unattached
Stuart, W. T., Captain 17th Regt. Staff, Jamaica.
Fonblanque, E. B. de, Dep. Com. General

HER MAJESTY'S INDIAN FORCES.

Macaulay, G. W., Capt. Comt. 1st Sinde Horse
Day, H. J., Capt. H.M. 19th Bom. N.I.
Haggard, T. T., Major R. A. Bombay
Birch, W. B., Lieut. H.M. 15th Bengal Cavalry
Holt, J, Capt. H. M. 20th Bombay N. I.
Grant, J. M., Capt. H.M. Bombay Staff Corps, Major of Brigade, Bangalore

MILITIA.

ENGLAND.

White, C. H., Capt. and Adj. 1st Roy. Cheshire
Balguy, C. Y., Capt. and Adj. 1st Derby
Woolcombe, R. W., Surgeon, Devon (Artillery)
Ashley, Lord, Lieut.-Col. Dorset
Hall, G., Lieut.-Col., Durham (Artillery)
Digweed, W. H., Maj. Hampshire
Campbell, J. R., Capt. Hants Artillery
Greenwood, J., Maj. 5th Roy. Lancashire
Bent, W. H., Capt. Roy. East Middlesex
Carter, J. M., Lieut.-Col. and Adj. Roy. Monmouth
Percy, Right Hon. Earl, Lieut.-Col. Northumberland
Dillon, Conrad A., Lieut. Oxford
Harwood, E., Capt. 2nd Somerset
Adair, R. A. Shafto, Col. Suffolk (Artillery) A.D.C. to Queen
Dawes, E. A., Capt. 2nd Roy. Surrey
Flower, L., Capt. 3rd Roy. Surrey
Walker, S., Lieut.-Col. Queen's Own Light Infantry
Baxter, S. S., Capt. 1st Warwick
Norris, G. G., Capt. 2nd Warwick
Fyers, H. T., Lieut.-Col. East and North York (Art.)
Wade, H. C., Col., C.B., North York Rifles
Craven, C. D., Capt. 5th West York
Le Couteur, J., Col. Roy. Jersey, A.D.C. to Queen.

SCOTLAND.

Walker, G. G., Maj. Scottish Borderers
Spenlove, J. F. S., Lieut. Fife (Artillery)

IRELAND.

Stawell, W. St. Leger Alcock, Lieut.-Col. North Cork (Rifles)
Balcombe, J., Capt. and Adj. Roy. South Down
Forbes, Hon. W. F., Major, Leitrim Rifles
Vereker, Hon. S. P., Maj. Limerick City (Artillery)
Caulfield, J. A., Lt.-Col., Royal Tyrone Fus.

YEOMANRY CAVALRY.

Tottenham, C. J., Lt.-Col., Denbighshire
Mildmay, Sir H. B. P. St. John, Bart., Lieut.-Col. Hampshire
Portman, Hon. W. H. B., Col. West Somerset
Stanhope, W. T. S., Capt. 1st West York

VOLUNTEER CORPS.

Artillery.

Haworth, B. B., Lieut.-Col. Yorkshire
Walmisley, J. R. L., Lt.-Col. Comt. City of London

Engineers.

Coffey, T. A., Capt. Comt. Tower Hamlets.

Engineer and Railway Volunteer Staff Corps.

Gregory, C. H., Lieutenant-Colonel

Rifles.

Acland, T. D., Lieut.-Col. Devon
Lombard, G. C. S., Capt. and Adj. 21st Middlesex
Styan, A., Capt. 22nd (Queen's Westminster) Middlesex
Charter, E. J., Major, late 11th Regt., Adjt. 22nd Queen's Westminster Rifle Volunteers
Grey, R. W., Lieut.-Col. 26th Middlesex
Hutchinson, J., Lieut.-Col. 8th Lancashire
Davidson, D., Lieut.-Col. Edinburgh City
Dartmouth, Earl of, Capt. Stafford
Lindsay, H. G., Lieut.-Col. Brecknockshire
Rouse, R., Capt. Suffolk
Mein, A., Maj. 4th Lanarkshire
Thorold, G. E., Col. Kent.
Hardinge, Viscount, Lieut.-Col. Kent
Ratcliff, C., Capt. 1st Warwickshire
Dighton, T. D., Capt. London Rifle Brigade
Cavendish, W. H. F., Lieut.-Col. Comg. 2nd Derby Rifle Volunteers

Officers wishing to become Members of the Royal United Service Institution can copy one of the subjoined Forms, and inclose the copy to the Secretary:—

Form for becoming an Annual Subscriber.

_____186

It is my desire to become a Member of the Royal United Service Institution; and I hereby request and authorise my Agents [or Bankers], Messrs._____, to pay my Entrance Fee and Annual Subscription now, and as it becomes due on the 1st January in each year, to the Secretary of the Institution.

_____Signature.

_____Qualification for Membership.

Form for becoming a Life Subscriber.

It is my desire to become a Life Member of the Royal United Service Institution; and I hereby authorise my Agents [or Bankers], Messrs._____, to pay my Entrance Fee and Life Subscription to the Secretary of the Institution.

_____Signature.

_____Qualification for Membership.

Entrance Fee—One Pound.

Annual Subscription—One Pound, which entitles a Member to receive the Journal; or Ten Shillings without the Journal.

Life Subscription Ten Pounds (including Entrance Fee), which entitles a Member to receive the Journal, or Six Pounds (in addition to the Entrance Fee) without the Journal.

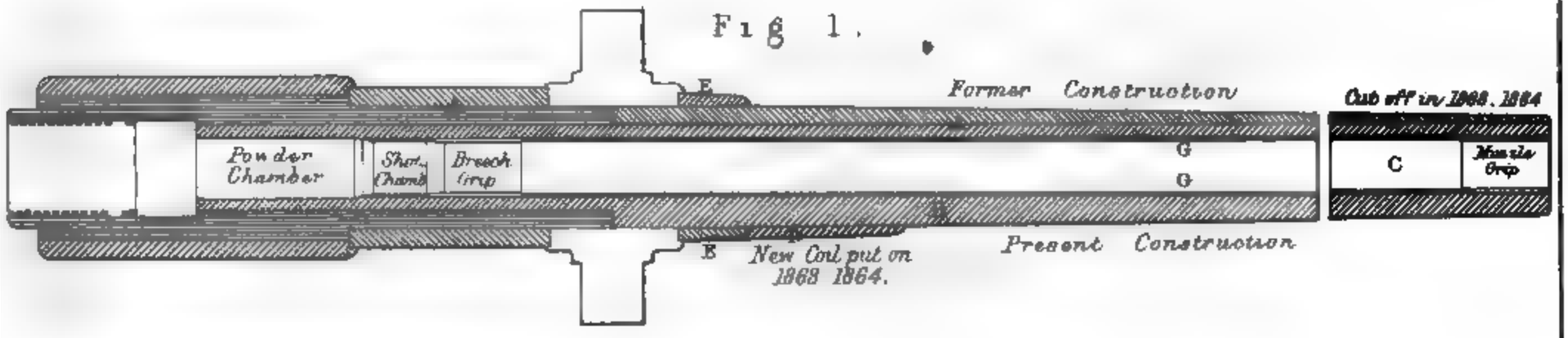
Form of Bequest.

I give and bequeath unto The Royal United Service Institution, *situated in Whitehall Yard, London, the sum of*

to be applied in and towards carrying on the designs of the said Institution, such Legacy to be paid out of such part of my personal Estate not specifically bequeathed as the law permits to be appropriated by Will to Charitable Purposes.

CONTENTS OF VOLUME THE EIGHTH.

ARMSTRONG'S 12 PRS BREECH LOADERS.

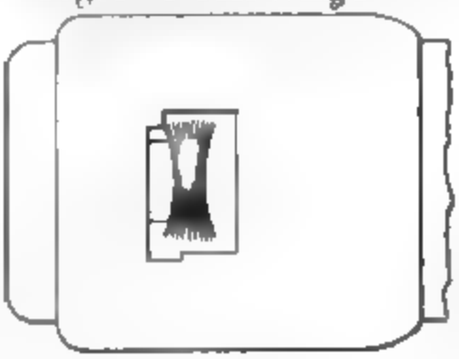


A Type of Gun designed to supersede the ponderous Artillery used at Sea
(See Sir William Armstrong's Letter to "Times")

J R Jobbins

Fig. 10. *Trajectory of*

Fig. 4 *1 Side Wedge*



Section at Muzzle

Fig. 4ª *2 Side Wedges*

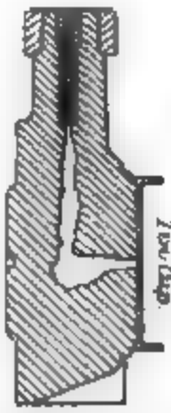
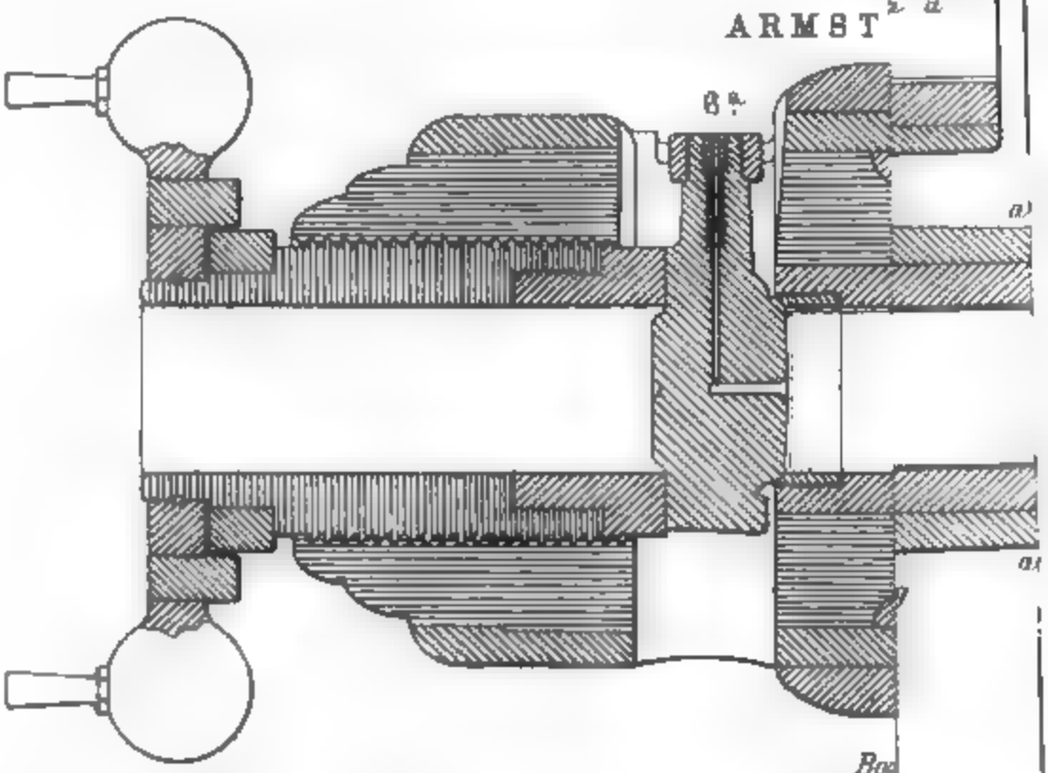


Fig. 6ª
Tin Cup

Fig. 6ª
Worn Vent Piece
Showing tin cup forced back upon nose of Vent Piece which jams it into the bore, as the Gun Expands by being heated

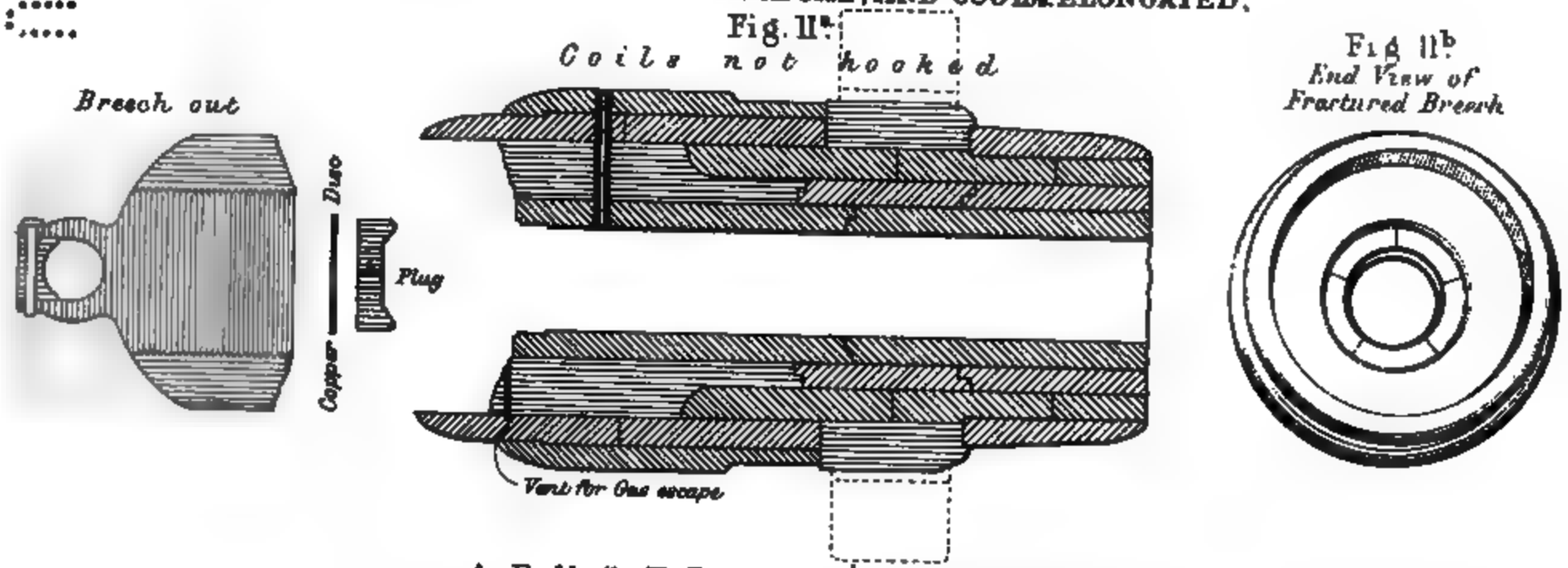


A
12 lbs Powder

B
14 lbs Powder

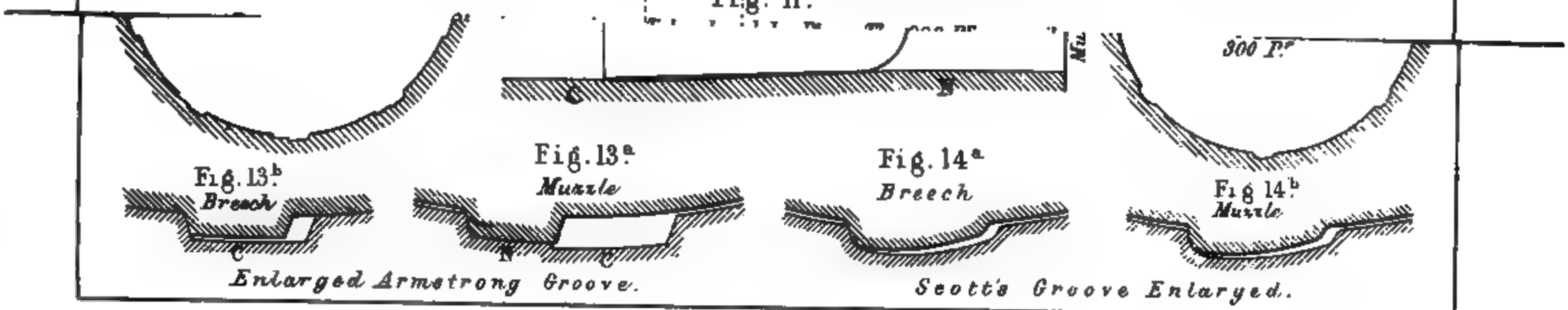
R. Johnson

12 TON GUNS, SHOT 150 lbs. SPHERICAL, AND 300 lbs. ELONGATED.



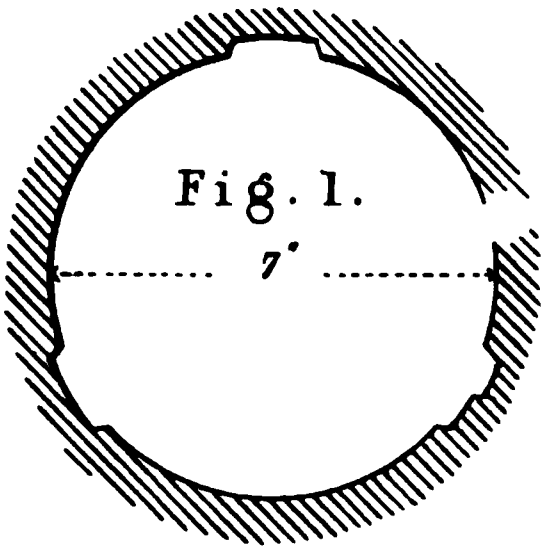
ARMSTRONG'S GUN.

Fig. 11.



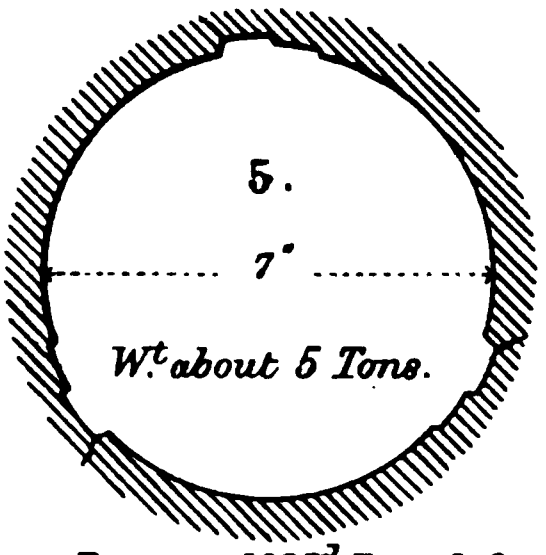
SKETCHE

1859 to 1860, 1 Nipping Groove.

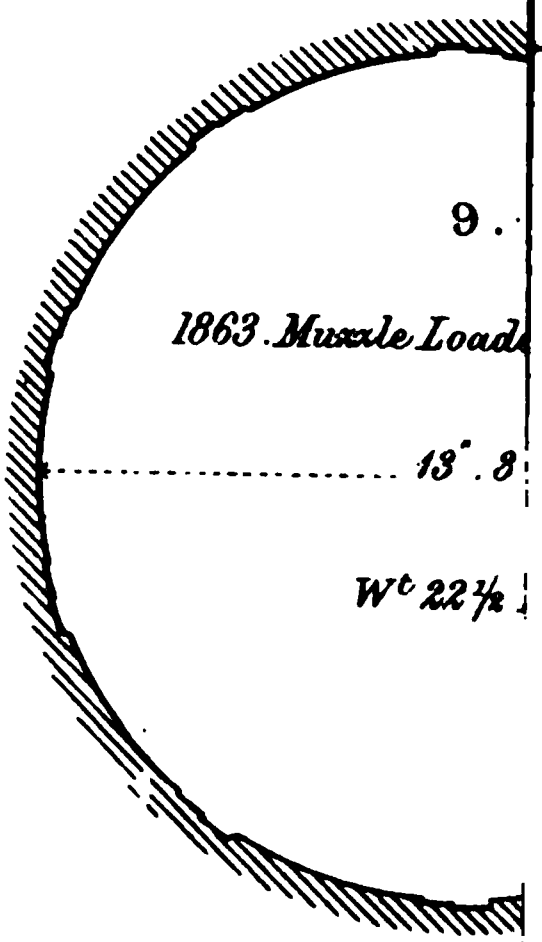


4000 Ordered
300 Supplied
About 100 Hooped

3 Nipping Grooves
1861, Breech and Muzzle Loading
120 Pr.



Latter Burst at 103rd Round, former repaired after 20 Rounds.



J.R.Jobl

The Journal

OF THE

Royal United Service Institution.

Vol. VIII. 1864. No. XXX.

Evening Meeting.

Monday, February 1st, 1864.

Colonel P. J. Yorke, F.R.S., in the Chair.

LIST of MEMBERS who joined the Institution between 19th January, and 1st February.

LIFE.

Bascvi, J. P., Capt., R. E., Bengal, 2*l*; Scratchley, P. H., Capt. Royal Engineers, 9*l*; Barrow, W. P., Lieut. R. N., 9*l*.

ANNUAL.

Maclean, Allan, Cornet 1st Royal Dragoons, 1*l*.
Minty, R. G. P., Ensign 12th Hants Rifle Volunteers.
Travers, E. A. B., Major Madras Staff Corps, 1*l*.
Barron, N. J., Lieut. 2nd bat., 5th Fus.
Legge, W. D., Lieut. 2nd bat., 5th Fus.
Vincent, J. L., Ensign 2nd bat., 5th Fus.
Harison, O., Ensign 2nd bat., 5th Fus.
Manby, Chas., Capt. 7th Lan. Art. Vols., 1*l*.
Bruce, A. C., Capt. 91st Regt.

NAVAL ORDNANCE.

By Captain E. G. Fishbourne, R.N., C.B.

Mr. Chairman,—When last I had the honour of lecturing in this Institution, I expressed myself strongly as to the injustice that had been done to the service by neglecting the smooth-bore gun, and then complained that great initial velocity of projectile had been so undervalued that none of the recent guns admitted of more than very low

[illegible] I had my experiments [illegible] with a view to obtain [illegible] property. There is [illegible] for this com- [illegible] William Armstrong is said to have [illegible] the neg- [illegible] and after persuading the public that the adoption of [illegible] being made lighter, on the discussion of my [illegible] that rifled guns must be heavier than smooth-bores. [illegible] that in this he had [illegible] the principle; this, [illegible] is not so, for though he has partly reinstated the round [illegible] to fire it from, he is still constantly making [illegible] without any real progress, because he still clings to the [illegible] principle of his original design.

[illegible] that this entails great damage to the interests of the [illegible] and not perceiving any hope in the artillery experiments, of [illegible] satisfactory change, seeing that the apparent principle in [illegible] only that of "working out" the erroneous system that has [illegible] adopted. I solicit your attention while I contrast that [illegible] with those of other competitors which offer greater advan- [illegible] with a view to my defining more distinctly the gun of the [illegible].

[illegible] allow me to run over the changes that have been made in Sir [illegible] Armstrong's guns, to show how truly I had predicted their [illegible].

[illegible] to the multigroove. 2nd. As to the shunt.

[illegible] Plate I. Fig. 1 you perceive the early construction, the salient [illegible] of which are the coil system, (which Sir William said, in [illegible] before the Committee of the House of Commons (Ques- [illegible] was "the essential part of his system.") and the number [illegible] which the coils are put together, shown at A.A.E. G.G re- [illegible] the rifling.

[illegible] a great reduction in the number of coils (see lower [illegible] B: D. Fig. 1. shows a large coil put on in front of the [illegible] 1863–4; C, a piece recently cut off the muzzle; and in [illegible] have his competition gun with a steel barrel, completed with [illegible] and breech coil; the object of the one being apparently [illegible]-holder, that of the other to give weight.

[illegible] William Armstrong, it will be remembered, did not agree to my [illegible] on his coil system. He said that Captain Fishbourne, refer- [illegible] the 110-pounder (Plate II, Fig. 6), pointed out various overlap- [illegible] that it must necessarily happen that the parts must draw [illegible] and so on. However, said Sir William, "all that is met by [illegible] that it does not take place, and I need not argue the ques- [illegible]"

[illegible] very true, that steel tubes may be advisable for other reasons [illegible] that of the inability of the coils to stand the wear and tear upon [illegible] which I shall have again to revert to, but I must beg your atten- [illegible] to Plate I, Fig. 2, a drawing of a 12-pounder taken from the re- [illegible] of the Parliamentary Committee, showing the parts drawn asunder [illegible] opening behind the trunnions, and fractured in a line with them, [illegible] need that *I* should "*argue the question further.*" I may also [illegible] you to the guns on this system which are now to be seen in the

Arsenal, to satisfy you how dearly bought has been the experience which has led Sir William to adopt other than "coiled iron" tubes, notwithstanding that he had asserted their "*inferiority.*"* In the multigroove, Plate II, Fig. 6, you see the service plan of closing the breech. Fig. 4 shows the earlier plan with one wedge; and Fig. 4a, the present mode, viz., of substituting two wedges for the *breech-piece*, improperly called a vent-piece.

I will not detain you with a description of Sir William's varied plans of multigroove rifling, of which the most important are shown in Plate I, Figs. A, B, C, D, E, nor tire you with a long list of unsuccessful fuzes, costing thousands of pounds, or with an enumeration of the numberless changes in the patterns and also in the material of breech-pieces, bouchings to stop the leakage of gas, wads to prevent leading of the grooves, breech-screws and sights; together with the vast quantity of special tools necessary to keep these in order, all arising out of the erroneous principles involved in the original design.

The various charges of powder and shot are shown in Plate II, by letters A, B, D, E, and F, with Boxer's lubricators C, together with the spaces occupied by each when in the gun, Fig. 6.

I shall, however, have to advert hereafter to a few more changes,† meanwhile, we may examine the "shunt" in the varied phases of its career. In Plate IV, Fig. 1, you see the germ of the system in 1859, *one* nipping-groove only; obviously *that* could not succeed, for it drove the shot all on one side. In 1860 (see Fig. 2), we find *two* nipping-grooves with iron bearings for the shot to travel on, then we have plain projections *upon* the bore, Fig. 3, and then plain grooves *in* the bore, Fig. 4, then in 1861 we have *three* nipping-grooves, Fig. 5, and for the first time after two years' firing, *soft metal* bearings.

Fig. 6 shows a 70-pounder with six grooves, and Fig. 11 a lately finished 70-pounder with only three grooves, which looks like a retrograde step; yet three is the number adopted in the competitive 12-pounder shunt-gun with a solid barrel, represented in Fig. 10.

From the projectiles with hard metal bearings, with one row of studs to take the muzzle-squeeze, we pass to shot entirely of iron, then to zinc strips for bearings, and from zinc strips to brass buttons—changes sufficient surely to have suggested that there was something palpably wrong. I therefore need not dwell longer upon the peculiarities of the large family of the "shunts," but may be permitted to refer to my former lecture, in which I pointed out that the smooth-bore gun and the rifled-gun had not been compared on equal terms—that no just estimate of their relative values could be arrived at till "equal genius" had been expended in developing the properties of each class of gun,

* Sir William Armstrong says, "I was compelled for a time to make the inner tubes, contrary to *my principle*, from a solid forging instead of from coiled iron, and the result has proved the inferiority of the plan."—E. G. F.

† All Sir William Armstrong's plans of breech-loading have failed, as was virtually admitted in the adoption of muzzle-loading guns; and his application of the coil construction has likewise proved as unsafe in practice as the mode of its application was wrong in principle.—E. G. F.

and yet the vicious inequality then complained of, is still persisted in, to the great injury of the public service.

I remarked in my former lecture on the great difficulty of obtaining accuracy with rifled ordnance, on account of the necessary unsteadiness of ships at sea, but I *did* not urge anything against the utility of large powder capacity and long range for breaching and destroying at great distances, though Sir William Armstrong in replying to my observations, implied that I had done so.

The comparative flatness of trajectory of the round ball at short ranges, as compared with that of the rifled shot, arising from the greater initial velocity of the former, was established together with its greater general effectiveness at sea from the same and from other causes —see Fig. 10, Plate II, wherein it is shown that the round ball would hit any object not less than 12 feet high at any part of the trajectory, while the rifle ball would pass over objects more than 40 feet high.

The enormous tension that must be occasioned by the alteration which has to be effected in the lead coating of the multigroove shot, and by the nip at the muzzle both of the multigroove and shunt guns, was pointed out, and I stated that the smallness of the recoil of the former guns was no proof that there was little friction, but the reverse, for it was the intensity of the friction of the shot in passing out which prevented the recoil of the gun, and absorbed a large portion of the force that ought to have been employed in giving a higher velocity to the shot.

I dwelt on the injury it was to a naval gun to have the shot detained, as in the multigroove rifled gun.

I insisted that instead of making the pure rifled gun all and all, giving up the "substantial advantages of low trajectory, straight ricochet, smashing force, simplicity and economy for the very, occasional advantages of long range, we should make round ball firing, the basis of our system, adding such a rifling as would not interfere with it, but give us the desirable advantages of rifled guns and their capacious shells, without sacrificing any of the enumerated advantages of the round ball."

This I stated would exclude all multigroove guns, or those with a *sharp edged rifling*. I pointed out some of the most glaring defects of the coil system, of the lead-coating system, and of the strip system, and after reviewing the other rifled guns proposed by different inventors, concluded that the system of Captain Scott, from the simplicity and indestructible nature of its projectiles, from its capability of firing round balls and all other missiles used for guns, was the best suited for naval purposes.

My lecture was given in May, 1862, and the notice therein of the various systems will render unnecessary further mention of them, except so far as may be requisite to illustrate the principles set forth in this paper. As so much has been given up, it might be said that nothing remained to object to; but the fact is, that though the changes have been those merely of detail, the erroneous principles involved in the design, both of the gun and the missile, are retained, and carry with them all their pernicious consequences.

Some of our ablest artillerists never accepted Sir William Armstrong's systems as correct; some are now of opinion that the multi-groove is a failure, and that this will soon be generally acknowledged, we are led to conclude, from the admission of admirers of the systems in speaking of their limited performances when used against iron plates at very short distances. To use their own language, they say, they are "quite insignificant," "almost inappreciable," and the effects produced by the 120-pounder shunt-gun, the same authorities confess, were "*not much more.*"

The many shifts in the shunt rifling and the hesitation to adopt that system in the army, indicate an opinion in the minds of the inventor and his admirers that it is not adapted for that purpose. But as there are a few influential persons who still cling to Sir William Armstrong's systems as if they thought neither of them radically bad, it will be necessary for me to prove that they each so extensively violate mechanical and artillerist principles, as not to admit of effectual improvement, and that a continuance of the use of either cannot fail to end in disaster.

The problem is how, with the limited strength and limited endurance of metals, together with the necessity for limiting the weight of ships' guns, and their projectiles, to obtain the greatest effectiveness, or how, with a given sum of money, to obtain a gun, that under the varying circumstances of warfare, will effect the greatest damage.

Viewing the subject practically, we are bound by several conditions:

1stly. That the distances at which naval actions will be fought are constantly altering, and cannot, therefore, be accurately measured. They will, however, be generally much within 2,000 yards, and only exceptionally above that distance.

2ndly. That with a given weight and strength of gun, and weight of projectile, the highest relative velocity, and the quickest exit of shot from the gun, should be provided for.

3rdly. That the gun should possess the capability of being used with spherical, as well as elongated shot, without injury to the grooving, and be also able to fire molten iron shells, grape, cannister, &c. These capabilities are little short of *indispensable* where only one or two guns are carried by vessels.

If a correct mode of procedure be adopted, these conditions are easy of attainment, and then every other quality, in the necessary degree, may be given; but it will be impossible fully to meet them, unless the size and form of the projectile be such "that it will only occasion the *least tension on the gun.*"

Time and tension enter largely into almost every artillery question, yet most unaccountably they seem to have been altogether overlooked by those who, for the last few years, have had control in artillery matters in our country; for this, amongst other reasons, time and tension should have our first consideration.

The more slowly motion is at first communicated to the projectile, and the less it is obstructed afterwards, the less will be the tension upon the gun.

We know that a pressure of about 7 tons per square inch applied,

uniformly over 8 feet of a smooth bore, will give an ordinary round shot 1,600 feet of initial velocity:

7—7—7—7;

but the amount of power required to produce any given velocity of projectile will vary much as it is well or ill applied. The greatest results would be obtained by applying the pressure slowly at first, and afterwards in an increasing ratio for the purpose of accelerating the shot.

Afterwards the *order* of the pressures in this case might be somewhat as represented by the numbers:

3—6—9—12.

By such an adjustment of the pressures a much higher initial velocity might be obtained, as the power would be greater, and yet the gun would be less strained, as the higher pressures would be employed only when the shot was receding fast from it, and so relieving the gun. This arrangement, nevertheless, is neither applied, nor sought to be applied, in any gun extant, while in respect of some ordnance, it is so much violated as to occasion rapid deterioration and early destruction.

In practice the nearest approach to this application of the pressures is in the old smooth bore, in which there is a large amount of windage that prevents much of the sudden tension that would otherwise arise from the mode of igniting its large powder charge. The application of the pressures in the smooth bore may be represented by the numbers:

5—11—8—4

A considerable reduction of windage, say from ·21 to ·08 inches, would give an equal velocity with $\frac{1}{4}$th less powder, or a greater velocity with an equal quantity, but occasioning greater initial tension. The pressures in this case may be represented by the numbers:

6—11—8—4.

A rifle projectile of the same diameter as the round ball, but double its weight, and relieved in some measure by windage, will produce a very much greater strain upon the gun, in consequence of the detention of the shot by its rifle wings, and its greater inertia. These causes give time for a larger portion of the charge to be converted into gas than in the smooth bore, before the projectile moves and relieves the strain. The order of the pressures in this case would be somewhat as below, varying, of course, with the angle of twist, &c.:

8—12—6—3.

A rifle projectile, on the expanding principle, and double the weight of the round ball, would occasion still more tension on the gun, as there would be no windage to relieve it, for the projectile on its leaded base being driven out into the rifle grooves and tightly closing the bore, would, from the great friction this occasions, be moved with difficulty. More time would, therefore, elapse, and a greater portion of the powder would be converted into gas before the projectile was in motion, than in the case of a rifle shot *with windage*. An approximate estimate of the tension in this case is given by the numbers:

10—12—6—3.

But of all the projectiles extant, that which is more than double the weight of a round ball of the same diameter, and is of a diameter greater than the bore, involving the necessity of its cutting its way

through the rifle grooves, and is subjected to a sharp squeeze at the muzzle, must, of necessity, occasion by far the greatest tension upon the gun. This cannot be placed at a lower pressure in tons per square inch than the following numbers represent:

$$18-9-4\tfrac{1}{2}-2\tfrac{1}{4}.$$

The last estimate has reference to the multigroove, and the proof of the high tension is to be found in the following:—

1st. Mr. Bashley Britten's gun, with an expanding rifle projectile, and a charge of only $\frac{1}{10}$th the weight of his shot, gave an initial velocity of 1,209 feet per second, while Sir Wm. Armstrong's multigroove projectile, with a charge of $\frac{1}{8}$th its weight, attains no higher velocity than from 1,140 to 1,200 feet per second; that is, Mr. Britten's shot, in attaining the higher result, does not occasion to the gun so great a total strain as that of Sir Wm. Armstrong by *at least* $\frac{1}{4}$th, while the initial strain on Sir William's gun must be double that on Mr. Britten's.*

2nd. One of the Parrot rifled guns, a muzzle-loader, with an expanding projectile, gave an initial velocity of 1,254 feet per second, with a charge of $\frac{1}{10}$th the weight of its shot, and other American guns have given 1,244 feet with charges a shade more than $\frac{1}{10}$th.

That I have rather understated the tension occasioned by the multigroove shot is clear from Sir Wm. Armstrong's own words, in answer to questions put to him by the Defence Commission. He said, "If you fire a long shot with a heavy charge, you attain a point at which the material begins to crush, the metal in the chamber yields to the pressure, and is displaced; the gun begins to loose its form;" and again, he replies, "1,200 feet is the proper initial velocity."

Although costly coils of wrought-iron, capable of standing a compression of 17 tons to the square inch, are *necessitated* by the use of Sir Wm. Armstrong's projectile to obtain even this *low* initial velocity, it should be borne in mind that merely common cast-iron guns were used in the trials by Messrs. Britten, Haddon, Jeffrey, Lancaster, and Captain Scott, and the tension that such guns are considered capable of bearing with safety, does not *exceed* 12 tons per square inch.

Serious evils likewise arise from the projectile of the multigroove being made larger than the bore, through which it is detained in the gun, and greater heat is given out by the more immediate combustion of the cartridge in the chamber. This rapidly warms the inner tube, which does not readily part with its heat again, the consequence is, that portions of the lead-coating of the projectile are melted, and roll in small globules along the lower grooves of the gun, fouling the rifling, and, consequently impairing the accuracy of the firing.

In addition to the excessive initial tension, there is a violent strain arising from the squeeze at the muzzle,† both in the multigroove and

* In fact, the pressure of forcing a 25lb. Armstrong shot *slowly* through the bore by mechanical means is said to have exceeded 40 tons.—E. G. F.

† The effect of these constrictions is that sometimes the shell bursts *in* the gun, damaging the rifling, sometimes near the muzzle, to the danger of friends. This

shunt-guns, tending to pull the chase from the breech. This is so excessive, as sometimes to split their muzzles, and it has the peculiar disadvantage of checking the motion of the projectile just at the place where, as already shown, the greatest acceleration should be given.

These squeezings at the muzzle and breech of the multigroove, and the danger of such pressure crushing up the shells, effectually prevent, without further complication, the firing of molten iron. The muzzle squeeze in the shunt-gun is equally dangerous,* but the higher initial velocity, with equal charges, obtained from this gun, indicates the greater detention and friction of shot in the multigroove, and, therefore, the higher tension upon the gun. At my last lecture, in 1862, it was asserted that both the multigroove and shunt could be fired with as much safety as the smooth-bore, with charges ¼th the weight of their shot, and that, therefore, the strain caused by these methods of rifling could not be so great as I then represented it. Experiments were accordingly made, and the result was, that all the heavy guns which were fired even with smaller charges than ¼th the weight of their *proper shot*, were put *hors de combat.*

1st. The 110-pounder multigroove, was rendered unserviceable by firing a 100 lb. shot with 25 lbs. of powder, a great portion of the vent-piece was driven to the rear, and the remainder so jammed in, that they were obliged to blow it out from the muzzle. The lands of the rifling were flattened, the coils of the gun split, and the breech damaged.

Next, the usual 126 lb. shunt-shot was reduced to 98 lbs. weight, and fired with 24½ lbs. of powder, from the 120-pounder shunt-gun (Fig. 5, Plate IV), which was so damaged at the breech as not to be worth repairing.

On the failure of the large multigroove and shunt-guns, built on the Elswick coil principle, to stand charges of one-fourth the weight of the shot reduced for them, the ground was changed, and very exceptional experiments were made with useless shot—useless because they turned over and gave no accuracy.†

arises from the shell starting with considerable velocity, on which the hammer inside the fuze is liberated and falls back, partaking of the shell's velocity, when this is checked by the squeeze, either near the breech or muzzle, the hammer moves forward, ignites the powder, and bursts the shell. This always takes place in the multigroove if the shot is not jammed home against the nip. The fact is so well known by those who understand the intricacies of the gun that they seldom load it when *elevated*, which in chase would entail a constant alteration of elevation, and corresponding uncertainty of fire.—E. G. F.

* A breech-loading shunt-gun, of 8 tons weight, was so much bulged in the bore by the tight-fitting zinc projections on the shot, that, after only eight rounds had been fired with 30lbs. of powder and a 150 lb. shot, it became unserviceable. —E. G. F.

† Major Mordecai's careful and scientific experiments shew the velocity of the American smooth-bore 12-pounder, with a charge of one-fourth the weight of its shot, to be 1,759 feet per second; allowing, then, for the loss by the difference of windage, and for the difference of eleven calibres, by which Whitworth's gun was longer than the American, and also for the closed windage and the less length of Sir William Armstrong's gun, we, according to Major Mordecai's formula, get the following :—

The value of these when fairly estimated according to their striking velocities, as compared with those of round shot, are given below,—

Value of the round shot as compared with Whitworth's, as 50 to 42.

Value of the round shot as compared with Sir W. Armstrong's, as 44 to 35.

Apart from the fact that such rifle projectiles were utterly unfit for service, no allowance was made in the experiments for the inequality of tension upon the guns, which was considerable according to Sir William Armstrong's own statement, for he says that "holding back the projectile" (by the rifle grooves and by the contraction in the chamber), "until the powder is converted into gas, gets a higher pressure upon the projectile," and therefore I add necessarily a higher pressure on the gun also. Then Whitworth's 12-pounder not having a constricted chamber like the multigroove, should have been given a larger powder charge, and the smooth bore being without either rifle-grooves or constricted chamber, should have been fired with a still larger charge, before any fair comparison as to the relative velocities of shot fired from rifled guns and from smooth-bores could have been instituted.*

I further showed, in May, 1862, that owing to the distances at sea being unknown, the greatest accuracy and the greatest damage to iron plates could only be effected by the highest velocities of projectile; the endeavour to adapt short shot to the Armstrong guns is an admission of the truth of this.

The figures contained in the following Table, compiled from those given in the Appendix to the Defence Commission Report, clearly show the importance attached to high velocities, while they afford another proof of the total disregard of all fair conditions that characterise the comparisons of smooth-bore ordnance with Armstrong guns. This table is given by me to show how fallacious are the views that have been made the basis for conclusions affecting great national interests.

American 12-pounder, smooth-bore..	1759	
Loss by difference of windage	150	
" " calibre	121	= 2053 against 1900 feet initial velocity of the Whitworth.
And again the same—		
American 12-pounder	1759	
Loss by difference of windage	173	
" " calibre	16	= 1916 against 1746 feet initial velocity given by the Armstrong 12-pounder, with charges of one-fourth the weight of these special shot.

And the public were told that these velocities were greater than could be obtained from the smooth-bore. The public were not told that these exceptional velocities were obtained with plaything shot; nor were they told of the difference of tension, the difference of windage, and the difference of the length of the guns, though each of these influence considerably the amount of initial velocity.—E. G. F.

* Such experiments only serve to mystify; for, with such shortened shot, long range, and accuracy, which alone could justify a departure from the simplicity and other exclusive properties of the spherical ball, are lost; in fact Sir William

Nature of gun.	Weight in lbs.		Initial velocity.	Remaining velocity.			
	Powder.	Shot.		200 yards.	1000 yards.	2000 yards.	
150-pounders, 10½-inch smooth bore	50	150	1766	1624	1200	925	By experiment.
300-pounders, 10½-inch rifled gun	75	300	1715	1665	1425	1215	
300-pounders, 15-inch smooth bore	80	300	1750	..	1150	..	
600-pounders, 15-inch rifled gun	62	600	1100	..	..	812	0·7 windage.

The tables from which the above is extracted have the appearance of being a record of facts, yet they are but speculations.

And while the 150-pounder is said to be fired with a charge of only 50 lbs. of powder as a 10½-inch smooth-bore, a 300-pounder 10½-inch rifled gun, which is exactly of the same weight and strength, is to be fired with 75 lbs. of powder and a 300 lb. projectile!!

That is, weakened so far as rifling does weaken, this wonderful piece of ordnance is by this process deemed to have been made strong enough to bear a strain with a rifle projectile *upwards of three times* the amount that was considered sufficient before it was rifled; and even to this greatly increased strain a large addition must still be made for constriction of chamber and muzzle squeeze in the multigroove, or for muzzle squeezing, if it be a shunt-gun. Again the so called 15-inch, which is but 13·3, is to be fired with 80 lbs. of powder, with a 300 lb. round ball, yet this very same gun, directly it is rifled, is deemed capable of withstanding the strain of a 600 lb. elongated shot, with 62 lbs. of powder.

If the proper charge for this gun with a 600lb. shot is 70lbs. of powder, the quantity it has lately been fired with, then the equivalent charge with one spherical shot would be 140 lbs., yet it was fired with this shot, and only 70 lbs., indicating either a total disregard of artillerist principles, or else one of the great defects of the shunt system, the inability to sustain firing round shot with proper charges, without injuring the sharp edges of its rifling.

The fancies of this table, as contradistinguished from the facts of experiments, show how great has been the delusion as to the value of the Armstrong coil-guns.

The vaunted 150-pounder smooth-bore was *proved* with a single charge of 70 lbs., one of 80 lbs., and one of 90 lbs. of powder, which is rather under the proper proof charge, but it was so strained that it

Armstrong himself stated that he could not obtain any degree of accuracy with rifle projectiles under 2¼ diameters long.—E. G. F.

Since this paper was read, another shunt-gun, with an inner tube of steel has been burst in the proof!!—E. G. F.

soon afterwards burst with 50 lbs. of powder, and a spherical shot, fracturing and blowing its breech a great distance to the rear. Plate III, Figs. 11, 11a, 11b.

Coil guns are said to be repairable, so this gun was put through some such operation, and was then fired with a spherical shot with the modest charge of 45lbs., and was again cracked under a strain about *one-fourth of that which this Table represents it as capable of bearing.*

Another 150-pounder rifled on the shunt principle was fired both with 150 lb. round balls, and 300lb. elongated projectiles, with *only* 35 *lbs.* of powder to *test* the power of endurance of the Bellerophon target against the heaviest guns, prior to constructing a new class of ironclads, that is, this *very important national experiment* was made with considerably less than half the charge which, according to the above Table, is the proper one for a coil 12-ton gun. The initial velocity of the 300 lb. rifle projectiles fired on this occasion was said to be only 1,100 feet per second, instead of 1,715 feet given in the Table, and therefore the striking velocity would be as 18 only, instead of 43!

It is clear, then, that the target was not half tested, and that the whole thing was a mockery; the more palpably so, that the blows struck were less than would be given by shot from the American "Monitor" guns.

The following description of one class of Sir William Armstrong's guns (the 110-pounder) will give some idea of the evil of his rule:—

Plate II, Fig. 6, shows a section of a multigroove showing that it, like all the service breech-loaders, is held together merely by the tightness of the outer coils, which are shrunk on over the inner coils.

Plate III, Figs. 11 and 11a, show the general formation of 10 guns of 12 tons each (10½ inches bore), in which will be perceived the loose breech-plug, A, with copper disc behind, which latter necessarily crushes up. To remedy the evil of thus weakening the breech, there is a hole made in the rear of the gun to allow an escape for the gas that passes the plug.

Plate II, Fig. 6a, is a sketch of a vent-piece in which the reaction from the explosion of the charge, owing to the detention of the shot, aided by the fire from the detonating tube, has eaten out a large cavity at the angle in the vent, which would retain the moisture either from the discharge or from rain, and would likewise catch any burning matter from the discharge, that might ignite the next charge prematurely, or the moisture prevent its ignition at all.

This form of vent-hole also materially weakens the vent-pieces, and they not unfrequently expand and become fixed in the gun; they are sometimes fractured in the use of only blank cartridge—a sufficient ground, in the estimation of practical men, to have prevented the adoption of the gun.

Another evil of this double vent is that much time is lost before the cartridge is ignited, and as the shot is detained by the constriction of the mouth of the chamber, slow-burning powder is used with a view to limit the danger arising from this detention. From these causes a

much slower discharge of the missile takes place than in the smooth-bore gun.

These arrangements are specially fatal to accuracy when a ship is rolling, for as the quantities are all unknown, any correct allowances in action are simply impossible.*

The projectiles, also, are subject to rapid deterioration; the Elswick shot are already being releaded in the Royal Arsenal,—a process about as expensive as melting up the old and making new shot.

The form of this decay is shown in Plate II, Fig. 7a, which was drawn from an actual 40-pounder shell—Fig. 7 shows the original shell. Such projectiles would of course be too large, from the large blisters on them, to be put into the Armstrong breech-loader—a gun which unfortunately cannot fire any other kind of projectile.

Added to these disadvantages, are those arising from the mode of loading; a chamber the size of a special charge, and a formation that necessitates the use in the 110-pounder of tin saucers, that require to be changed every round, and which, if $\frac{1}{1000}$th part of an inch out of gauge, will occasion mishaps with the gun; from which an idea may be formed of the straits that are likely to occur to officers all over the world where these guns are.

Owing to the detention of the shot until, to use Sir William Armstrong's own words, "the whole of the charge is converted into gas," the gun is subject to a tension *indefinitely large*,† hence the metal of the chamber is crushed up with even low charges, and with high charges the gun is at once destroyed.

The evil effect of even a 12lb. charge is seen in Plate II, Fig. 6b, where from the stretching of the rear of the gun, an opening was left of sufficient width to allow the tin saucer to be thrust back over the nozzle of the vent-piece, which it held fixed in the gun, necessitating the use of mechanical appliances before the vent-piece could be removed for reloading.

Again, because of the constricted chamber (Plate II, Fig. 6 H), the whole volume of the gas is, according to Sir William Armstrong, evolved before the shot starts; its velocity afterwards is merely sustained by expansion, consequently the pressure is very small where it ought, according to true principles, to be the greatest, at the muzzle, and yet at this very point the evil is increased by the shot being retarded by a squeeze, II, a.

In contradistinction to this, we find that the Americans, in the Atwater gun (Plate II, Fig. 8), cut away the lands near the muzzle to give the shot a freer exit, and obtain a range of 2,800 yards at 5° elevation, with a powder charge of $\frac{1}{8}$th the weight of the shot, while the Armstrong shortened projectile requires $\frac{1}{4}$th its weight of powder charge to attain an equal range.

The injury done by the practice of contracting the gun at the

* The Japanese report that a large number of Armstrong shells were found far up in land, having done no damage from having gone over the town.—E. G. F.

† It has been found that when powder is burnt in a confined chamber equal to its own volume it occasions a tension of 90 tons per square inch.—E. G. F.

muzzle was further proved by a French gun, which, through having holes bored in the chase, recoiled considerably less than before. Again, Sir William Armstrong's 12-pounder was not impaired in range (though so much shorter) or in acccuracy, after having its muzzle, which contained the muzzle nip, blown off by its own charge.*

Plate III, Fig. 12, shows the superiority of Mr. Anderson's plan of making guns over that of Sir W. Armstrong.

It will be observed that the former have not only their coils hooked together, but have also solid-ended inner tubes, owing to which they will possess greater strength and endurance. Higher velocities, therefore, may be safely obtained from them.

From their defective mode of construction, 12 of the 12-ton guns, built at Elswick, costing £1800 each, are unfit for rifling.

Our Transatlantic Cousins are fully sensible of the value of high velocities. The following Table gives the initial velocities of some of their and our own rifled guns:—

POWDER CHARGE ONE-TENTH THE WEIGHT OF RIFLE PROJECTILES.

Name.	Initial velocity.	Strength of powder.	Windage.	Nature of gun.	Bearings.	Relative weights.
Britten	1213	1170	Nearly closed.	Cast-iron.	Lead.	
Jeffery.....	1181	"	"	"	"	
Lancaster	1149	"	·04	"	Iron.	
Parrott (American)	1254	—	Nearly closed.	Cast-iron — Jacketted.	Brass ring.	
L. Thomas	1277	1248	Nil.	Cast-iron.	Lead.	
French.....	1148	"	·12	"	Zinc buttons.	
Armstrong:—						
Shunt	1173	"	·04		Zinc stripes.	
40-pounder ...	1081	"	Nil.	Coil.	Lead.	
Initial Velocities with Rifle Projectiles in terms of weight of Powder Charge.						
Armstrong's shunt 600-pounder ..	1172	—	·04	Coil.	Brass buttons.	$8\frac{5}{7}$
Haddan	1277	1170	·17	Cast-iron.	Iron.	$7\frac{5}{7}$
Shunt, 600-pndr.	1275	—	·04	Coil.	Brass buttons.	$7\frac{4}{7}$
Parrott	1405	—	Nearly closed.	Cast-iron — Jacketted.	Brass ring.	$7\frac{2}{7}$

The American 10-inch naval guns throw shot of 125 lbs. weight, with charges of 30 lbs., and have a special charge of 43 lbs. to be used against thick iron plates. This charge has been fired from the same gun as often as 400 times without injuring it; but the brass rings of

* In consequence of the above-stated experience the muzzles of all the 12-pounder guns were ordered to be cut off.—E. G. F.

their Parrott projectiles slip over the rifling when fired with larger charges than those at present employed.

Our own experience, when lead-coated shot are fired with large charges, is similar, for portions of the lead melt, and the shot cut their way out without taking the rifling properly. These failures point unmistakeably to the necessity for seeking a description of projectile and mode of rifling, that will, with a strong gun, admit of the use of large powder charges, and consequently give high velocities.

As the shunt is different in principle from the multigroove, and also from the Parrott rifle gun, we may examine what prospect it affords of giving the high velocities required for iron-clad warfare.

Plate III, Fig. 13, shows a transverse section of a 10 groove 300-pounder shunt gun.

Plate III, Fig. 13a, 13b, show cross sections of an enlarged shunt groove at breech and muzzle, and shot, and will illustrate the action which takes place on the explosion of the cartridge when the shot is driven from the loading side of the rifle groove to the bearing side, which it strikes heavily, and then hugs closely.

Fig. 13c, shows a longitudinal section of part of a gun, from which it will be perceived that on the foremost end of the shot arriving at the incline at the commencement of the nipping-grooves, N.N., its end is raised upwards, and a new direction is given to the shot; not, however, without a resistance proportionate to the rapidity with which it is travelling.

Its new tendency, according to the first law of motion, is to continue with its whole *vis insita* in the line of motion last imposed upon it, which is to pass out through the upper side of the gun, as shown in the Figure; and this tendency is very much aided by the increased tension brought on the gun by this action, for the shot having moved along the bottom of the bore (see CCC) till pushed up by the incline, shuts off the passage of the gas by its fore end coming in contact with the upper side of the bore, and still more completely shuts it off below by its base closing the windage at that point.

If the gun is strong enough to resist the strain of a charge large enough to give a high velocity, there is a great probability that the projectile, if a shell, will break up; or if a shot, that its brass (stud) bearings will yield before it is forced into a new direction by the upper incline, but in any case the repetition of such shocks could not fail rapidly to weaken, and prematurely to destroy the gun.

The greater the velocity of the shot the greater will be the danger of such a result, despite the softness of the stud bearings.*

As might be expected, the practical result of these nipping-grooves

* The Ordnance Select Committee report "that the shunt involves some peculiarities of construction in the projectile, which, in their opinion, may possibly, at a future period, lead to its rejection on practical grounds, however ingenious in principle, and however successful it may be in the experimental practice at Shoeburyness. They allude particularly to the *ribs or studs of zinc*, of which there are no less than 24 on the projectile of three different sizes, and requiring 24 slots for their reception. These ribs are so disposed that the shell cannot fall anywhere on its side without falling on some of them," and therefore injuring them, thereby preventing loading.—E. G. F.

is to pull off the muzzle. They also prevent quickness of loading the projectiles, which are liable to jamb in hasty loading.* They also prevent the use of molten iron, which in the Portsmouth experiment set the vessel on fire, so that she was burnt to the water's edge, before the fire could be extinguished. Captain Hewlett's report on the value of molten iron is conclusive.

The object of all these complications and dangerous expedients is to centre the shot; but this, as has been long since shewn, could be done more effectually by the grooving proposed by Captain Scott for large guns, and by General Boileau for small arms, and which is the simplest and most scientific of all the plans that have been brought forward.

Fig. 14 shows a transverse section of a 7 groove 300-pounder, with Captain Scott's centrical rifling.

The action of the shot in the two kinds of grooves—the shunt and Captain Scott's—are shown in Figs. 13a, 13b, and in 14a and 14b. On the explosion of the powder, the rifling of the latter having a rounded bearing, the first pressure of the elastic fluid brings the shot up evenly, raising it off the bottom of the bore, from whence it passes out smoothly and without oscillation upon, as it were 3, 5, or 7 rails, according to the size of the gun.†

The shunt-grooving represented in Figs. 13a and 13b, on the contrary, having flat sides, the shot on starting strikes against the bearing face of the groove with a blow which, if it does not split the gun after a few discharges, as in the case of the 120-pounder in 103 rounds, then the brass studs made soft for the purpose of deadening the blow are liable to be sheared off; the intense friction also from the constriction at the muzzle causes the rifling rapidly to wear, consequently accuracy of fire disappears.

The softness of the copper or brass studs upon the projectiles renders them very liable to get out of shape, so that the shot in loading cannot be got home to the cartridge.

Either from this cause or the limited windage (·04 to ·05 inches), or partly from both, the projectile of the 600-pounder stuck at the 6th round, and the gun subsequently required to be washed out after every round. In the 300-pounder shunt the same defects were found, the 3rd shell (steel) fired against the floating Warrior target burst *in* the gun—from, as was alleged, *not being home.* I ought to mention that the shell broke up in taking the nip (cutting up the bore); this is a sufficient explanation of the dangerous accident.

The sharp angles of the shunt-rifling, especially the deep corners on the loading side of the grooves, are a very great element of weakness, as metals always have a tendency to fracture at the angles.

* It is sought to provide against these evils by having a bearer fixed to the muzzle of the gun; but such an instrument is not likely to be used in action; so the shunt gun would most likely be spiked in loading by its own shot!—E. G. F.

† Fig. 14 represents a 12-ton gun rifled on this method as compared with Sir William Armstrong's, and shows that only half the amount of surface of the bore is taken out, and that no sharp edges are left, and hence Captain Scott's plan is better for firing round shot than the shunt.—E. G. F.

The ill effect of these deep corners is very apparent in the 120-pounder shunt (see Plate IV, Fig. 5), and they are very difficult to sponge properly.

The shot also oscillates in the gun, as was admitted by Sir William Armstrong in his evidence before the Parliamentary Committee, and this motion can only be prevented in this system by a tightness of fit that prevents easy loading.

The danger from this mode of rifling is shewn in the fact that many of the guns rifled on this principle have given way after a few rounds, and one gun after the 4th round.* No gun rifled on any other principle burst under 51 rounds.

Not long since, one of the 12-ton 150-pounders (Fig. 7) rifled on this system, and then called a 300-pounder, was only fired 5 times with elongated shot before its muzzle was cracked. It was also fired 3 times with spherical shot and a disproportionately low charge, and then sent to the "Excellent" for *exercise*, but *on no* account to be fired.

As the larger breech-loading Armstrongs had not been previously employed in warfare, the following extracts from letters of officers who were engaged at Kagosima, Japan, will show how little these guns are to be relied on, and the extent of their failure when fired with low charges, shows how disastrous would have been the consequences had they been fired with such high charges as the 16 lbs. occasionally used in target-practice at Shoeburyness.

Extract, November 3, 1863.—"The 12-pounder all right both days, "but the 110-pounder was a complete failure the second day. The "first day when fitted with time and concussion fuzes, we made some "admirable shots. The second day, no shells fitted with the pillar "fuze, went more than 300 yards, most burst *in* the gun, and nearly "all the shot *stripped*, some going as much as 600 yards to the left, "several of the grooves were cut out half way down the gun. Either "the poor thing is too delicate to be fired in a heavy rain for six hours, "or else the poor thing ought not to be left loaded for 24 hours in "any emergency."

Another extract.—"At all events, the second day nearly all the "110-pounders were useless, but the 40-pounders went all right. "Most of our work was done in from 200 to 400 yards, so that by "musketry we drove them away from the guns, knocked the guns "over with shot, and blew up the magazines with shells and rockets. "The Japanese shots at 2,300 yards with 80-pounders and 130-"pounders were excellent. We hope to get a real heavy gun instead "of the Armstrong, 'a *solid* 68-*pounder pivot*.' They are the best "guns out."

Another extract, November 20, 1863.—"In the 'Euryalus' 110-"pounder pivot, one vent-piece blew out, and one from a broadside-"gun, which split and stuck inside, knocked down the gun's crew, "but did no damage. In us the pillar-fuze and common shell burst "prematurely every time, taking five inches in length of rifling out of

* And yet it was gravely asserted that they could be used with charges of one-fourth the weight of their shot.—E. G. F.

"the gun amidships right round, and going half an inch into the "metal of the gun. Every shot fired afterwards, stripped. The "'Perseus,' 40-pounder pivot, blew out a vent-piece. The 'Race-"horse's' abuse their gun horribly, and wish they had two solid 68's, "as the practice from the after gun was so superior and quicker than "that from the Armstrong."

Another Extract:—

"I am sorry to say that the Armstrong did not impress us as being "such a first-rate gun; in fact, all to a certain extent failed; a shell "burst in ours, and cut up the rifling a good deal, knocked holes in it, "a vent-piece damaged and condemned. Some few days will make "the gun efficient again. The shell with concussion fuzes, which are "brought from the shell-room and put into the gun, without being "touched, nearly all burst at the muzzle of the gun; nor can they fire "at short ranges so quickly as the old 68-pounders."

An experienced Gunnery Officer wrote as follows, respecting the behaviour of the Amstrong guns at Kagosima:—

"I have received further information on the same subject, and learn "that the defects were more than at first reported. The practice also "appears to have been worse with the Armstrongs than with the "smooth-bores."

Another Officer says:—

"It is a pretty general opinion that the 110-pounder is not fit for "sea-service or rough weather. It was blowing hard, and the first "day it rained. The 110-pounder missed fire eight times; the first "shot was not till we had been under fire 20 minutes. The 68 "missed fire only once; no accident happened to it; it was always "ready when wanted, made first-rate practice, and fired quickly. "The 110 made bad practice at close quarters, and was no better at "long shots than the 68.

"Could not get the 110-pounder off on four occasions; once not "under 28 minutes, from the vent-piece jamming. This happened "three times. The 68 knocked over 5 guns; 110 did not touch one.

"The pillar fuze failed in the Argus; one shell burst in the gun, "and stripped the grooves, so that after that the shot could be driven "through the gun with the rammer; every shell after burst, and the "shot were useless. Perseus had two vent-pieces blown out of "40-pounders. Coquette's vent-pieces *jammed* three times—one time "when under fire for half an hour. The cry is 'give us the old 68's again.'"

So calmly reviewing all the facts placed before you, and others* that I have not time to dwell on, I can come to no other conclusion than, that of all the projectiles and systems of rifling that have come under my observation, and these have been many, the lead-coated shot and the multigroove gun of Sir Wm. Armstrong, are amongst the worst,

* A month after the action at Kagosima they were still trying to grind out the effects produced by the shells bursting in the guns of the "Argus" steamer. —E. G. F.

The Japanese have since reported that all the damage done was by the "*big round ball.*"—E. G. F.

if not the most erroneous in "principle," and his shunt shot and grooving, though better, are far below many others.*

I proceed now more distinctly to indicate the qualities necessary in a naval gun:—

1st. *To fire Round Ball, as well as Elongated.*—It is clear that nothing will compensate for a low velocity, especially when firing against forts or ships. To attain this, we must have either smooth-bore guns, or what is better, guns with a description of rifling that will admit of the general use of spherical shot, as well as the rifle ammunition,† such guns will not require to be kept up to the limit of endurance by firing rifle projectiles constantly, but can be used with the round ball with comparatively little strain, when this kind of shot can do the work, and the round ball is especially adapted for rapid firing at close quarters.‡

In firing, the time occupied by 7 men, running the *American* 15-inch gun to battery, depressing it from maximum elevation, sponging, loading with *round* ball, and elevating ready to fire with maximum elevation, was—

First trial, 4 minutes. Second trial, 3 minutes and 10 seconds: with gun horizontal, the time running to battery, sponging and loading, was—

1st trial, 1 minute 52 seconds; 2nd, 1 minute 28 seconds;
3rd, 1 „ 10 „ 4th, 1 „ 15 „

500 rounds were fired, and no wear or enlargement was found.

The time occupied at Shoeburyness in firing "Big Will" varied from 20 minutes to 10 minutes each round. After *a dozen or twenty rounds it was found that the chamber had become slightly oval, and the inner tube had started.*

Nor is it matter of opinion that round shot are more effective at short ranges; it is as much a matter of law as that the elongated shot will range further.

Up to a certain short distance a round shell, if sufficiently tough, will, from its higher velocity, be more effective than a solid sphere; over that distance, and up to another, the solid sphere, from maintaining its velocity longer, will be more effective than the shell, beyond this a medium elongated shot, and then an elongated shot according to length.

It is sometimes argued that a sphere is a bad form for penetrating, but the object being to smash in the part assailed, the round ball,

* Captain Sir William Wiseman, some time Vice-President of the Ordnance Select Committee, stated, in his evidence before the Parliamentary Committee, that there were many other systems that he preferred to the shunt.—E. G. F.

† My gallant friend, Admiral Halsted, will be glad to learn that the Admiralty have ordered a number of smooth-bore guns. To make the order complete, they have but to add that these should be rifled on some good plan, that will not impair their efficiency as smooth-bore guns.—E. G. F.

‡ I am glad to be able to quote the opinion of Colonel Boxer, Superintendent of the Royal Laboratory, Woolwich, and long a member of the Ordnance Select Committee, who, in an able pamphlet, says, "If, therefore, a system of ordnance could be devised, combining the advantages of both (the smooth-bore and rifle), there could then remain no question as to its general introduction."—E. G. F.

from concentrating its blow upon a limited part, and from its leverage for fracture, is better than a flat-headed projectile; and the late results with round steel balls, which passed through 5 and 5½-inch plates, making destructive missiles of the broken pieces of plate, justify the above conclusion.

Moreover, the rifling increases both the accuracy and range of spherical shot, as it gives them a slight rotation, and hence a definite direction.*

The idea that round shot will necessarily glance off, is likewise groundless; an elongated shot is only prevented by its rotation from turning over, consequently at the first impact it glances.

The greater the velocity the less is the chance of glancing.† An American correspondent says:—

"One round shot penetrated her after turret, speaking of the Keokuk, the sides of which it will be remembered are frustrums of cones, while the turrets of the monitors are perpendicular cylinders; another shot passed through her port bow, and still another through her starboard quarter. These were all steel projectiles of 100lbs. weight, and polished to the smoothness of a knife blade. The terrible effects of those projectiles may be imagined when it is stated that one of them striking the *after turret at an angle*, when the vessel was almost under the walls of the fort, buried itself in the iron mail, and there remains." Windage of these guns was 0·12 inches.

The very great value of high initial velocities has been quite overlooked, but proceeding on the assumption that penetration was as the square of the velocity, the value of the smooth-bore 68 was placed at 17, as compared with the 110-pounder Armstrong, which was valued at 16, and a quantity of fine writing was added by way of proving that if the fact was not so, it ought to be so. The practical answer to all this, is the hard fact that the 110-pounder penetrates at 200 yards $1\frac{6}{10}$ inch, and the 68-pounder with steel shot 4 inches, and the 100-pounder smooth-bore, also with steel shot 5½ inches of plate, making a hole in addition, that men actually passed through.

That we have not steel shot in general use, is amongst the evils of Sir William Armstrong's rule. As early as 1859 Mr. Whitworth, by putting a bolt through the "Trusty," showed the value of steel, and in fact that it was indispensable to success against iron clads; and yet nearly all the time since then, while we, as well as foreign nations,

* This was proved by experiments made by the Ordnance Select Committee with Captain Scott's rifled guns, in May, 1860, and with Mr. Britten's rifled gun a year later.—E. G. F.

† The idea that round shot must glance has arisen from not considering the influence which the element of time and velocity exercises in all such questions. If a ball, or even a candle be fired at a door standing open, and the velocity be considerable, either will pass through the door without its moving on its hinges; if, on the contrary, the velocity be small, the door will move, because time will be given for the elasticity of the wood to act, and the candle and, it may be, the ball, will be thrown back; this is analogous to what occurs with plates of armour; if the velocity be high, there will not be time for the elasticity of the plate to act, the ball will, therefore, enter; nor does this property of penetrating more truly belong to the flat-headed shot than to the sphere, but less. *There is also no straightness of ricochet from the rifle ball.*—E. G. F.

have been building iron-clads, our arsenals have been employed in making shot for all descriptions of guns quite useless as against them; and Elswick has had extensive employment also in making these brittle shot, the result of which is, that we have now nearly a million pounds worth of nearly useless stores.

Lead-coated shot must of necessity be thus fragile, for if the metal be heated for the purpose of effectually coating them, the temper is taken away; and if not heated the shot must be undercut, and still the lead flies off on the heads of friends, instead of on foes.

The influence of time also has been lost sight of in estimating the effects of shot on plates.

A shot that enters a plate does so at a much higher rate than as the square of the velocity, but this is gradually reduced at each increment penetrated, so that after a time its velocity is so reduced, that there is not sufficient to penetrate further.

From this follows—

1stly. That there will not be any penetration through the plate, unless the projectile moves at a certain high velocity.

2ndly. That the higher the velocity, the smaller within practical limits, varying of course with the plate to be penetrated, may be the projectile that will penetrate.

3rdly. The heavier the shot, the lower may be the velocity necessary to penetrate a given thickness of plate.

4thly. That for a given weight of shot to pass through a given thickness of plate, there must be high velocity at impact, proportionate to the thickness of the plate, so that a sufficient velocity may remain to penetrate the last portion of the plate.*

The rifling of the gun should be such as will not be injured by firing round shot, and we have determined that iron bearings alone will admit of the *highest velocities*, and it is simply folly to be content with anything short of these, for as has been shown, the higher the velocity the smaller may be the projectile, and therefore the smaller and lighter the gun. The only two forms of rifling that offer are Mr. Whitworth's and Captain Scott's, but the inability to fire spherical shot and molten iron is fatal to the former, and the angles of the grooving are an element of weakness in the gun: this leaves no choice but to use that of Captain Scott, which has this further to recommend it, that the gun is much less strained, and the form of groove is somewhat like that of the French gun, from which the highest comparative results have been obtained; its projectiles also, as I mentioned in a former lecture, are little liable to injury.

Windage.—The amount of this, in various guns, ranges from ·015 to ·210, and when I pointed out the loss arising from giving the larger quantity, I was told that less could not be given without bursting the gun. The smaller quantity is preposterously small, as is that given to the 300 and 600-pounders (·040 inches), for in neither case would there be sufficient for service, for unless the gun was mopped out, as

* No estimate as to penetration at 2,000 yards by a slow moving body can be formed from the penetration effected at 200 yards by a fast travelling body.—E. G. F.

the 600-pounder was after nearly every shot, the gun could not be reloaded.

The proper quantity should have been determined long since, but it certainly should not be *less* than ·060.

The system of giving rotation by studs does not admit of sufficient windage, nor would studs admit of sufficiently high velocities, for they cut half through with the present charges; yet the 600-pounder only yielded 1170 feet initial velocity with steel shot, when fired at the floating Warrior target; yet in producing this low initial velocity, the gun has become slightly oval at the seat of the shot. There is a flaw* near the muzzle, or rather an opening round the bore, and the inner tube has also moved forward slightly.

Another advantage of Captain Scott's plan of rifling is that sufficient windage can be given. A certain amount affords facility for loading, and conduces to an easy and rapid exit of the shot. Nor is the escape of gas by the opening lost power, for it blows out the wad necessarily used at sea, which otherwise would prevent accuracy, and greatly increase the strain on the gun in firing rifle projectiles. It also drives out the air from the front of the shot, thus further relieving the gun from pressure.

2nd. *The cartridge* should be differently formed and ignited than is now the custom.

It should be ignited at the end next the shot, so that the first portions of the gas formed should start it, and the full force of the gas should act on it only when it was in motion. In a word, the powder should be burnt somewhat in the following order of time and quantity, the smallest (12, 8, 4, 2) quantity first, and the latter quantity to be of fast burning powder. The precise kind and quantity can only be arrived at by experiment.

This arrangement would, in a gun of a given strength and weight, admit of the use of larger charges or stronger powder, whether the shot were elongated or spherical, or equal efficiency, with less cost, or less weight for ships, and would avoid the danger from air space.

The Americans endeavour to obtain something like the object described by the use of cake powder, by which they effect considerable results with comparatively little strain on the guns. The powder, however, does not burn fast enough to give the high velocities required in ships' guns.

The French have long adopted a plan, the value of which has also been recognized in America as giving higher initial velocity, with less tension on the gun, though the reason they assign for this effect is not correct.

The cartridges are made up in cylinders smaller in diameter than that of the bore of their respective guns. By this the first increment of gas evolved passes over the remaining portion of the cartridge and starts the shot, before the remainder is converted into gas. The same results might be arrived at by igniting the cartridge at the fore end from the breech end, through a hollow tube in the cartridge, or better by the

* It is said now that the flaw existed before the gun was fired. It may fairly be asked why was it paid for as if perfect?—E. G. F.

substitution of gun-cotton for powder. This material seems to offer great facilities for evolving the gas at the most correct time, and in the quantity required. It possesses also other valuable qualities,—that of not occasioning smoke and not heating the gun in any degree comparable to powder; nor does it foul the bore; while it is also more regular in its action and safer to handle.

3rd. *Material.*—The Duke of Somerset asked, in May, 1862, when his Grace occupied the chair in this Institution, "whether it was proposed to give up cast iron altogether, and adopt wrought iron." This was hitting one of the great blots in the coil system, for misconception as to the action of powder, especially in the multigroove gun, led to the adoption, because of its greater strength for resisting the tension which the missiles of that gun entailed, of a metal for the interior of guns that was wholly unfitted for the purpose of withstanding the wear of rifle projectiles.

The action of powder exploding, partaking of the nature of a blow (witness the expansion of brass and of lead into grooves, and the enlargement of the chambers of guns), shows that a very necessary quality to have been sought in metal for guns was hardness. Cast iron was said not to have sufficient hardness, and that the balls indented the guns, and finally destroyed them. The American experiments established that wrought iron was more easily indented than cast iron, and for the obvious reason that the degree of hardness of the former is only 38,000 lbs., while that of the latter is 92,000 lbs. The cast iron was, therefore, better adapted for the interior of guns, and any requisite tensile strength would have been better added at the outside, as was done by Capt. Blakeley, the French, and others, or else greater tensile strength might have been obtained by improving the quality of the castings, as was done by the Americans, who, by this means, obtained more enduring ordnance than any of the Armstrong coil guns.

The strength or hardness of wrought iron under compression is equivalent to a pressure of 17 tons to the square inch, and the explanation of the cracks and flaws which are to be found in the chambers of the multigroove coil-made guns after proof, and which increase with use, is to be found in the fact that the metal has been compressed beyond its capability of endurance. In a word, *all these guns, from the time of being received into the service as sound, if in use, are in process of disintegration*, and only do not break to pieces because they either stretch, or the vent-pieces give way and relieve the gun. So that, at no distant day, they will all become mere obsolete stores, the only escape from which result will be, the use of *very limited* charges *and* a description of missile constructed on mechanical principles, instead of one designed on a plan which destroys the gun.

The decay of the Armstrong coil guns is looked upon as a matter of course, as is evident from the recent addenda* to the Queen's Regulations, which I may affirm, without contradiction, is without parallel in the history of this or any other country.

Extract from circular:—

* See also article on shot and shell, page 87 of Addenda.—E. G. F.

"Whenever a flaw is discovered in an Armstrong gun, an impression "of it in gutta percha or some other available substance is to accom-"pany the report made by the captain, together with a full description "of the position of the defect.

"Great care should be observed in reporting flaws. The gun should "be carefully examined when first received, as it frequently happens "that flaws have been reported as having been discovered after firing "a few rounds, which, in reality, existed at the time the gun was "issued.

"When the accident is with any of the parts of the gun, such as "the breech-screw or vent-piece, the whole of the marks on the vent-"piece or vent-screw should be fully described, and a drawing or "rubbing transmitted of the fracture or damage that may have "occurred."

Clearly, then, from the moment that cast iron was deemed insufficient, Bessemer's, or other steel should have been fully tested, more particularly as I observe from the reports of evidence that Mr. Bessemer offered to guarantee to supply metal that would bear a strain of 45 tons to the square inch. It is due to Colonel Wilmot to say, that he obtained the sanction of the Government to make guns of that metal as far back as 1859, and that he left in his office proofs of its value for such a purpose when he was superseded by Sir William Armstrong.

4th. *Endurance.*—Bessemer's metal, or indeed many kinds of steel,* can, by the use of the hydraulic press, be given a homogeneity, and therefore a certainty of character, quite unattainable either in coils or in ordinary iron castings.

The closeness of texture and hardness of steel admit of a smoothness of surface that will resist injury from the rapid formation and rapid flow of gases, as well as from indentation from the shot, and thus much conduce to endurance. Hardness will likewise ensure the continuance of accuracy by resisting the effect of the friction of the rifle-shot, which would wear down a softer metal.†

The extent of this evil is shown in Sir W. Armstrong's 70-pounder and his cast-iron 32-pounder guns, and also in B. Britten's rifled gun, and though the bearings of the shot in the former case were of soft metal (zinc), and the bearings of the latter, lead, neither have maintained the accuracy given by earlier discharges. (See Plate V of Diagrams of Error from O. S. Committee's Report on Competitive Cast-iron Guns.)‡

* Cast steel is less liable than any other metal in general use to become crystallised by *vibration*, which is a progressive cause of weakness in guns.—E. G. F.

† Charles Stewart, Esq., of the London and North Western Railway, says, "I cannot resist the fact that in certain points where the ordinary rails wear out in a few weeks the steel rail stands the wear and tear in a most extraordinary manner. We are expending £50,000 for producing rails, &c., on Bessemer's process."—E. G. F.

‡ I must not be understood as admitting the accuracy of the representations made in any of these parallelograms. The mode of applying the theory of probabilities in them is incorrect, and is another illustration of the dilettante-ism that has been imported into this question. A true representation of the facts would still further show the greater advantages of Captain Scott's system.—E. G. F.

Round shot of Bessemer's metal and of other steel can be made homogeneous and concentric, and hence great accuracy of fire may be ensured; spherical shells likewise can be made of sufficient strength to pierce ordinary iron plates.

It should be mentioned that Mr. Michael Scott, C.E., proposes so to adjust the centre of gravity of elongated shot as to obtain accuracy and length of flight without rotation, this, if effected, will dispense with the evils of rifling.

5th. *Calibre.*—The difficulties involved in this question appear to me not to have had their due weight, and we have been hurried into the partial adoption of monster guns by Sir William Armstrong, who, finding he could do nothing with his small guns, thought he would hold his spurs by performances, obtained at a very great cost, a cost quite disproportionate to the results. Each round fired from "Big Will" is said to have cost £60, and it is doubted whether its effect was much greater than that of the 100-pounder smooth bore at Portsmouth, or certainly might be, with a better devised gun of that size. Be that as it may, there are other considerations that should be weighed.

1st. The difficulty of controlling the motion of such guns, more particularly when the ship is rolling rapidly.

2nd. The increased difficulty of loading, even with round shot. With elongated shot there would be the complication and delay of machinery.

3rd. A much more limited endurance; owing to the greater proportionate heat from large charges, and the greater inertia and friction of such proportionately heavy elongated shot, the explosion will always be more violent. The surfaces, also, per square inch, of the chambers of such guns will be subject to a greater tension, as is evident from the following table:—

Calibre of gun.	Area of equal transverse sections.	Volume of powder.	Relative proportion of powder to one inch of chamber surface.
2 inches.	6 inches.	3	$\frac{3}{6}$
3 "	9 "	7	$\frac{7}{9}$
4 "	12 "	13	$1\frac{1}{12}$
6 "	19 "	28	$1\frac{9}{19}$
8 "	25 "	50	2
13·2 "	41 "	137	$3\frac{1}{3}$

Showing that the pressure from equal proportionate charges on a particle in the chamber of a gun of 2-inch bore is vastly less than that on a particle in the chamber of a gun of 13·2-inch bore, and that, therefore, a material, and a missile, and mode of construction and of firing, that might suit in a gun of 2-inch bore would be unsuitable for an 8-inch bore; and those that would suit in an 8-inch bore might be quite unsuitable in a 13-inch or 15-inch bore, suggesting a doubt as to the prospect of obtaining any reasonable measure of endurance from

EXTRACTS FROM O.S.C. REPORT DATED FEBY 6TH 1863.

"On Competitive Rifled Cast-Iron Guns" (all 32 Prs of 58 Cwt.)

AMOUNT OF ERROR AT 5° ELEVATION.

(The practical limit of distance for Warfare)

Britten *20 Rounds.* *16th November 1859*

Mean Range 1850 Yards.

tten *15 Rounds.* *3rd August 1861*

Mean Range 1898 Yards.

Scott *11 Rounds.* *23rd October 1861*

Mean Range 1975 Yards.

istrong Shunt *6 Rounds.* *25th September 1861*

Mean Range 1940 Yards.

Armstrong Shunt *9 Rounds.* *26th September 1861*

Mean Range 1952 Yards

LAST COMPETITION AMOUNT OF ERROR AT 2° ELEVATION AUGUST 2ND 1861.

Number of rounds Fired previous to this Competition

Rifling of Gun.	with elongated Shot.		Description of Shot.
3 Grooves	Scott	300	all Iron
5 Dº	Britten	263	Lead on base
Oval	Lancaster	138	all Iron
3 Grooves	Haddan	63	Dº
7 Dº	Jeffery	51	Lead on base

en *15 Rounds.*

Mean Range 912 Yards.

Scott *9 Rounds.*

Mean Range 1129 Yards.

Note. *These Diagrams represent the relative space required for half the number of Shot fired to fall within them. (See Report O.S. Committee)*

J.R. Jobbin

guns of very large calibre fired with charges that will give very high velocities, or velocities equal to the smaller guns.

I am strongly impressed with the belief that the 12 ton 150-pounder, if cast of Bessemer's metal, or other steel, and its strength judiciously used, by the application of well-devised missiles, &c., would be a far more effective gun than any of greater size. The results said to have been obtained from the French 30-pounder throwing 100 lb. elongated shot fully justify this view, for it is said to have pierced a 5½ plate at 1090 yards. Whether this be a fact or not, I have no doubt of its feasibility. In the face of the facts given in this paper, I may ask what is the object proposed by the competitive trial of Armstrong and Whitworth 12-pounders about to come off? No practical artillerist would form a judgment as to great guns from the results that trial with small guns will give, nor would any practical man recommend the adoption of either system of rifling for the navy, neither being suitable for firing round shot, &c.

I have not dwelt upon the cost of large guns, nor the cost of badly designed missiles, but as all mechanical questions resolve themselves into £ *s. d.*, I ought to state that a gun similar to the French steel 30-pounder, which sent a shot through a 5½ plate at 1,090 yards, might be made of Bessemer's metal for £100. Big Will cost £3,800, and much ado was made about its sending its shot through 4½ inches of plate at 1000 yards.

The most ludicrous fact is that the old 95 cwt. 68-pounder, which it was known as far back as 1859, would put a homogeneous shot through a 4-inch plate, and made an indentation of 2¼ inches with a cast-iron shot, was put aside, in part, for the Armstrong 110-pounder, that only penetrates from $1\frac{6}{10}$ to 2 inches; the Armstrong gun costing £650, the 68-pounder only £95!

I have shown that to obtain the highest results, at the least cost, the gun of the future most possess:—

1. The double capacity of firing round ball, and the elongated shot.
2. That arrangements as to vent and cartridge must be made for burning the powder to greater advantage than is the case at present.
3. That the calibre must not be excessive.
4. That the grooves must be simple and not liable to injury from firing the round ball.
5. That there must be windage of not less than ·06.
6. That the gun should be solid, and of Bessemer's metal or other steel.
7. The missiles should be of tough but hard metal.
8. The ribs on the projectile must be of strong metal, cast on the shot, and of a simple form to stand the greatest strain of rotation with high charges, be little liable to injury, and admit of sufficient windage.

In closing this paper, I submit that if we are to escape a repetition of the errors we are now suffering from, if we are to make progress henceforth, and if the confidence of men and officers in their guns, and in the judgment of those who rule in these matters is to be restored, all artillery experiments must be directed with reference to some comprehensive scheme to determine principles rather than

whether one gun shoots better than another, each placed under exceptional circumstances, and the judges must confine themselves to their proper province, and cease to be special pleaders for Mr. A. or Mr. B.

The CHAIRMAN: I am sure our thanks are due to Captain Fishbourne for this excellent paper, and for the great pains he has taken in bringing forward his views upon this subject. So interesting as it is at the present moment, I have very little doubt that there are many gentlemen present, who would like to make some observations; but it will be a question with the meeting, whether we should take the discussion now, or adjourn to another evening.

Admiral HALSTED: I think it would be more advantageous to adjourn it; I might finish my own part of the discussion simply in reply to Captain Fishbourne's remarks with reference to the 100-pounder which it is intended to rifle, by saying, that whenever we see those guns safely rifled, so as to give us the full advantage of rifled guns, in the proportion to what they now possess as smooth bores, we shall then recognise the possibility of the same gun doing the double work.

Captain LEOPOLD HEATH, R.N., C.B.: May I say a few words now, as I shall not be here to-morrow evening? My object is to put the meeting right upon some points in Captain Fishbourne's paper. Interesting as the lecture has been, it reminds me very much of what certain Commissioners did who came into the Crimea in the spring of 1855. During the previous winter everybody had suffered great hardships, and everybody had set his shoulder to the wheel, and they were getting everything into a good state, when out came this band of Commissioners; they re-touched what was going on with a little gilt here and a little paint there, and they came back and got the credit of all that had been done. I think Captain Fishbourne has been destroying things on paper, which have already been destroyed in fact. For instance, he complains that the muzzles of the guns break off because of the grip. The grip has been abolished. He complains of the undercutting of the shot. Undercutting was done away with two years ago. He complains of the simple shrinking on of the hoops. That plan is no longer used, and the hooking system, introduced by Mr. Anderson, has been substituted for it. The fact is that the state of the gun question is a state of progress; it is perfectly true that many of the defects pointed out in this gun exist; but it is also true that none of these guns are being made now, or have been made for a year. I think there may be small guns, some 20-pounders, that are being made, but nothing larger than that. Now, with reference to the Table of expansions, it is a curious Table, and I cannot understand it.

I will not go down the different lines of figures; but if any one of them could be proved to be a true representation of what takes place in a gun, it would be a most valuable contribution to the science of gunnery. Those who have tried their hands in determining the initial pressure of a given charge of powder with a given weight of shot before it, have come to most different results. I think Count Romford gave 40,000, where Mr. Robins gave 15,000 lbs. pressure. There was an enormous difference in the result of the experiments. There are experiments going on now which may, perhaps, elucidate it; a gun is being cut down, beginning at the muzzle, by successive lengths, and the initial velocity is being determined as the gun is being shortened. So far as it has yet gone, the experiment shows, that the expansion of the powder follows the law of all other gases, that it expands in the inverse proportion of the space it occupies.

The coil-tube is another instance which Captain Fishbourne gave us as a mistake. That, again, has been given up in all the recent guns, and steel has been adopted. As to Bessemer steel, it is an excellent material for rails, and it may be an excellent material for guns, but that does not follow; a railway rail has to do different work from that required of a gun.

Now, as to the velocities, I do not remember the figures, but I believe I am right in saying, that the comparative results of the two 12-pounders, the Whitworth and the Armstrong, were obtained with a Whitworth gun of 36 calibres long, compared with an Armstrong of 24 calibres, and that is not a fair comparison.

Captain FISHBOURNE: I took the fact from other people.

Captain HEATH: Now, when you take two guns, the Whitworth and the Armstrong of the same length firing the same weight of shot, and discharged by the same charge of powder, you get as nearly as possible the same initial velocity, with a little advantage on the side of the Armstrong gun. I wish it to be clearly understood, that I am not here to advocate Sir William Armstrong's system; my only object is to give you some accurate figures on the subject. Again, Captain Fishbourne tells us that the Armstrong 120-pounder shunt-gun produced as little effect upon the iron plate, or little better, than the Armstrong 110-pounder.

Captain FISHBOURNE: I beg your pardon, I quoted other authorities—admirers of the system used that language, not I.

Captain HEATH: I understood you to say, that the 110-pounder produced very little effect compared with the 68-pounder, and that the 120-pounder shunt-gun did little better.

Captain FISHBOURNE: I quoted other persons' language.

Captain HEATH: However that may be, I only wish to give you correct the figures; of course every body will understand, that all that a gun can do is to send a shot out of its muzzle, and when once the shot has left the muzzle of the gun, the gun can no longer influence it after that, its range and penetration must depend upon the shape and weight and hardness of the projectile. Now, with this 120-pounder shunt gun firing a 98 pound shot with 24½ pounds of powder, which is exactly one-fourth of the weight, the initial velocity, measured by Navez's electric apparatus, was 1,690 feet; the initial velocity of a shot from a 68-pounder is less than that.

Captain FISHBOURNE: Will you allow me to explain? Captain Heath is talking of a different thing altogether. He is talking of a gun that was altered for a particular experiment. The quotation that I made, had reference to the original 120-pounder with its original small charge, and which was given to the country as a complete gun, until the question was raised by myself eighteen months ago; and then a new series of experiments were made; the shot was shortened, and the charge was increased nearly one-half. I am speaking now of the shunt-gun.

Captain HEATH: It has never been in the service; there was only one experimental 120-pounder shunt-gun made. We are speaking of the same gun and the same experiment.

Captain FISHBOURNE: That was a subsequent experiment altogether; there was a shunt-gun in the service before that one.

Captain HEATH: They are all experimental guns; there is no shunt-gun in the service.

Captain FISHBOURNE: I mean for the service. It was received into the Arsenal, and accepted as a Government gun, and paid for.

Captain HEATH: There is only one of them; there has never been than more one that I am aware of.

Captain FISHBOURNE (pointing to the diagram): What are all these different guns, then?

Captain HEATH: I am speaking of the one which you say was fired with a 98-pound shot, and 24½ lbs. of powder.

Captain FISHBOURNE: That was not the one alluded to by the authority from whom I quoted those remarks, nor was it tried with that charge and with that shot until after I read my first paper here. We are speaking of a different thing altogether.

Captain HEATH: Well; the actual velocity of the shunt gun-with a charge of one-fourth the weight of the shot, was 1,690 feet, against the 68-pounder giving a velocity, I think, of 1,590 feet. Then, again, the same thing may be shown in various cases. Here is the 12-pounder Armstrong with a 2 lb. charge, and an 8 lb. shell; it had an initial velocity of 1,746 feet. Here is the 110-pounder gun, with 25 lbs. of powder and 100 lb. shot—that is one-fourth the weight of the shot—and its initial velocity was 1,591 feet, which is again slightly in excess of the 68-pounder. I think I need not quote any more examples. These figures are valuable, and should be remembered, for it has been the custom to compare smooth-bores with rifled-guns, without taking into consideration the relative weight of shot and the relative charge of powder. I think no such comparison is fair. You should

compare guns of the same weight, because in taking a given ship you must consider its scantling, and what weight of metal it will bear, and you must, I think, for a fair comparison, have the same weight of powder and the same weight of shot.

Captain Fishbourne: And the same tension on the gun.

Captain Heath: No comparison of that nature has yet been made. One will be made soon. There is a 100-pounder smooth-bore at Portsmouth, and a seven-inch 110-pounder of the same weight nearly completed. When these have been tested, you will have a better means of comparison.

Captain Fishbourne: A strong gun against a weak gun.

Captain Heath: Both of the same weight.

Captain Fishbourne: But not of the same make; the weak gun will not bear the same charge as the strong gun.

Captain Heath: There is another fact; the 110-pounder Armstrong gun, with its initial velocity of 1,125 feet, as proved by experiment, has a remaining velocity at 1,000 yards of 970 feet; the 68-pounder, with its 16 lb. charge, has an initial velocity of 1,670 feet; and its remaining velocity at 1,000 yards is 975 feet. That I must tell you is by calculation and not by experiment; but it is believed that the calculation is quite close enough for practical purposes. I thought perhaps these facts might be of use in the future discussion of the question, as I shall not be here to-morrow night.

Captain Fishbourne: Captain Heath has not objected to a single fact brought forward by me; on the contrary, what he has said has been to confirm my statements. He has said I was killing on paper that which was already dead, in fact, enumerating some points of detail which had been changed or abandoned. No doubt the principle of the gun and projectile was wrong, and the erroneous results have forced him to throw off, reject, and try to amend many of the details.

The country has been kept from having a gun and projectile upon a correct principle because those who ruled in these matters allowed Sir William Armstrong to be continually mending his hand at any cost to the country, hoping that, per adventure, he might some day get into the right groove.

The numerous changes and the palpable necessity for them would have conveyed to practical minds that there was no room for any such hope, and that any effectual cure must be a change of principle.

As to high velocities they were not thought of till I read my paper (1862), indeed, they were not to be necessary. Sir William said, in his evidence, that 1,200 feet was the proper velocity. No doubt the correctness arose from the fact that he could not obtain higher with safety and accuracy, of which he was well aware; and there are those who undertook to obtain higher velocities, and who thereby have lost the game. This is one of the points on which Sir William and his adherents have been at issue, four and twenty hours would scarce suffice to tell of their contentions which, if set in opposition, would, like the Kilkenny cats, destroy each other leaving only the tail.

And as for Captain Heath saying we shall have a fair experiment at Portsmouth, I fear it will not be a fair experiment, a weak smooth-bore gun that no one will think of the impossibility of firing a full charge from, with only a round ball is to be compared with a strong rifled gun, each carrying charges of one-fourth the weight of the projectile, unless there is equal tension on the guns, there will be no fair comparison.

Gentlemen, they will fire both one and the other, under circumstances which will be no true representation of any armour-plated ship whatever.

Adjourned Discussion.

Tuesday, February 2nd, 1864.

Lieutenant-Colonel T. ST. LEGER ALCOCK, in the Chair.

Commander W. DAWSON, R.N.: I wish to say a few words as a seaman gunner, and I am sure, if any other seamen gunners were present last night, they must, in common with myself, have learnt a great deal of the theory of gunnery, from the paper which was then read, and were, no doubt, equally pleased with the very clear illustration that we had of many of those theories, with which practical men are not so well acquainted as they ought to be. When I came into the Lecture Hall last night, I confess that I was almost an advocate or partisan of what I might call the "multi-system" principle. Believing that every system had something good in it, I came here expecting to hear something of each particular system. I expected to have heard, for instance, of the Whitworth system, of which elsewhere we have heard a great deal, but no officer that I have ever met with, has ever seen the gun fired; therefore, I should have liked to hear something more of it, more particularly as there is a Committee now sitting, which has been sitting for the last twelve months upon the subject, and has not yet come to any decision. Then there is the Bashley Britten system, which I have heard a great deal spoken of, and I should have liked to hear something of it. I confess myself very ignorant respecting it. I know its principle, but I am very ignorant as to how far it has been successfully tried. There are several other systems of which I should also have liked to have heard something. It appeared to me, that Captain Fishbourne confined himself rather to one system, the multigroove system, and he handled it so ably, that I must confess, instead of being a partisan of the multi-system principle, I feel very much inclined to be a partisan of the multigroove system, more particularly from the author's own statement. I rather think he began by trying to prove too much; he began by an assertion, that the multigroove system was acknowledged by everybody to be an effete system, and then proceeded to bring forward facts, which, I must confess, according to my experience, were somewhat exaggerated, and, in many cases, I should say misapplied, by which he proved, or sought to prove, that the first assertion that he made was a universally received one. For my own part, speaking as a seaman-gunner, who, in the course of service, has had the superintendence of the firing of some three or four thousand of these multigroove system projectiles, a great number of them in circumstances of motion, and very active lively motion,—some of them in a frigate, but the majority of them in a lively gunboat, and under circumstances of weather and motion, which, I think, form a very fair sea trial, the facts or conclusions that I arrived at, from what I observed, were very different. I must confess I saw very little of those horrible catastrophes which almost made one's hair stand on end last night; in fact, I think if I had known that it was such an awful gun as it is, I question very much whether, having a wife and a small family, I should have been doing right to trust myself behind the fire of such guns. But, happily, I was quite ignorant of these illustrations, and during the

experience of those three or four thousand rounds that I have seen fired, I must confess I never saw an accident of any importance. The accidents that did occur, I will refer to by and by. As to the gun itself, I am very well satisfied with the accuracy of the bore. There are two parts, I think, in the firing of a gun to be looked to; first, with reference to the internal part of the bore; secondly with reference to the sight. I should have liked to hear Captain Fishbourne go a little farther into the question of the sighting. He gave us some illustration with reference to the firing with motion—a very apt illustration, which I was very glad to receive, but I should have liked him to go a little more into the other question. With your permission, Mr. Chairman, I will presently say a few words on that subject. I will speak first with reference to the accuracy, and I will only state exactly what I have myself seen, giving not so much opinions as facts—facts which are reliable, and which have been seen by myself and other officers. With reference to the accuracy of these guns; this unfortunate one that got its muzzle blown off, or rather the fellow of it—not, I dare say, that identical one—was at Shoeburyness about four or five years ago, when the Armstrong gun first came out, and I was sent, as one of the naval officers to be instructed in the practice of this gun. One day we were practising at a target only 500 yards distance: the size of target at Shoeburyness is about 12 feet square painted black, and having a central line of white paint up and down, vertical and horizontal, and a bull's eye in the centre. On this particular occasion it was necessary to fire a concussion fuze shell into the central part of the target, which was strengthened behind in order to shew the action of the concussion fuze, the remainder of the target being of slight manufacture. In order to ascertain the centre, the instructor thought it was necessary to take a trial shot, and a trial shot was taken. Of course, had the elevation been exactly correct, and the shot had gone true, it must have gone into the bull's eye. It did not do so, but went about 30 inches below it. Making a certain allowance on the sight for that 30 inches, which speaking roughly from memory was about 6′, we put in another shot, the instructor was so satisfied that with those 6′ the shot would have struck the bull's eye, that he wanted to put in a shell, but the naval officers wished to make a complete bull's eye, so that to gratify them, one more shot was tried. To our astonishment, it came up to the horizontal line, but yet about 30 inches to the right of the mark. Our faith in this sight was then very much lessened. But we had a very intelligent captain of the gun on that occasion—a very intelligent gunner of the navy. He ran back to the sight, looked at it, and to his surprise found that his deflecting sight had been touched, which moved the deflexion about 5′ or 6′ to one side, thereby entirely accounting for the deflexion of the shot to the right. So satisfied were we with the result, that we now put in the shell, which went through the bull's eye, and of course we saw no more of it. This occurred to myself, and I relate it as being one of the many thousand shots I have seen fired, to show what the accuracy of the gun is from a steady platform. But I will give another instance, with reference to the 40-pounder, one of the guns that have not been abused. The Lords of the Admiralty came to Devonport at the time of the introduction of the 40-pounders into the naval service. We had not at that time one embarked, and I was commissioned to go to the gun-wharf and bring away a 40-pounder. I was instructed to embark that 40-pounder and anchor to a small anchor, in order to fire it at the Shag rock, which was at a distance of nearly 2,400 yards. I fired the first shot at it; I judged my distance and my sight so accurately—it was merely an accident I suppose—that it struck the rock the first time. I was perfectly satisfied, that if the sight did that once, it would do it fifty or a hundred times. I had such faith in the gun, for land purposes, that I went into harbour, and reported that I was ready to shew their Lordships this gun. I took their Lordships out, and in the passage out, I must say, I heard a great deal condemnatory of the gun. When they arrived out, they were very much astonished. The range fouled a little, so that we could not fire at the Shag rock, and we tried at a rock a little to the left. The first shot fell close to this rock; that, of course, I expected, but they were very much astonished. The range cleared, and we aimed a second shot at the Shag rock and struck it; we then aimed a third shot, and again struck the Shag rock, shewing that it was no accident. A little accident did occur, which, I must confess, was not known to any person present but myself. It occurred

to one of the sights—we must confess faults as we go along, but these are only little faults of detail—there are faults of detail, particularly in the matter of sights. The quoin flew out and struck the side sight, and bent it, but no one was aware of the fact. Fortunately for the credit of the gun, the range fouled, and no one knew that the sight had been injured. That does not affect the correctness of the sight, or the truth or accuracy of the gun. You will remember that I have been speaking of the gun on a fixed platform. When we come to a movable platform, we enter on quite a different subject; that is to say, a sighting which will direct a straight and true bore (as I believe the Armstrong gun to be) correctly to the mark from a fixed platform, will frequently fail to do so when fired from a movable platform. I am not going into the question of building ships, which involves the principle of a good platform; but I wish to put on record opinions I have formed from experience, shewing what those opinions were formed from, as to the correct object to be aimed at in sighting guns. Now with regard to the trunnion-sight of these new rifled-guns, that we can speak of as being admitted into the navy, and so far the best rifled-guns that we know of adopted in the world; the distance of the trunnion sight from the base sight is so small, that any little visual error in the gunner who directs the gun is multiplied. This does not appear on shore, because you go close up to the gun, lay it correctly, take your time about it, then walk away from the gun in a very leisurely way, and direct somebody to fire it. That is not the case afloat. You must stand to the extent of the trigger line, and the very fact of doing that, it may not be known to all present, but I suppose it is known to all seamen-gunners, causes a visual error, the error varying in amount according to the state of the atmosphere, and according to the fact of the gun being covered or uncovered, also according to the state and condition of the sights. This visual error, although variable in regard to quantity, is still constant. It varies from about $\frac{1}{16}$th to $\frac{1}{4}$th of a degree, depending upon these conditions. But in addition to that, firing afloat, particularly with the quick, lively motion of a gunboat, in which I have had my principal experience of this matter, is exactly like firing at a bird or a flying object. There will, therefore, be a certain amount of error in the eye. The eye will be a little above the tangent-sight, it may be a quarter of an inch or a half an inch. Now a little reasoning will show you that if the error amounts, say to $\frac{1}{4}$th of an inch above the tangent-sight, the error of the short radius from the tangent-sight to the trunnion-sight is in many cases, in that particular gun for instance, more than double what it would be if you had a dispart on the muzzle. Of course we know that there are difficulties and objections to disparts on the muzzle; nevertheless, I think, if the thing was properly sifted, and we concluded that the sights were badly placed, we should make an effort, if not to place disparts on the muzzle, at least to place them further out than at present. I see no reason, for instance, in the present broadside guns, smooth-bores, why our dispart should not be placed a foot and a half farther out. It would not interfere with the portsill, which is the only thing you have to consider. In our small gunboats, where there is a very lively motion, it is really essential that there should be a muzzle-dispart. Take the case of a boat's gun, not to weary you with too many figures, suppose the present short 20-pounder, as I think they call it now-a-days, was fired with a visual error of half an inch, which is not very much, not more than you usually expect. Now, that half inch, with the very short distance from the sight to the trunnion, would make an error of 277 yards; speaking roughly, we will say 300 yards. But if the sight, instead of being on the trunnion, was on the muzzle, the error would only be about a third, about 109 yards. That which first led my mind into this channel was a comparison between the 68-pounder, and the 40-pounder, and the 100-pounder. These guns were, as I have said before, fired simultaneously, that is, on the same day, and in the same circumstances of weather and motion, and it was generally observed that if we had a signal man always at a right angle to the range—and for all sea practice that ought to be the case, particularly if you want to make correct observations—it was observed that, at a distance of 2,000 yards, the 68-pounder, that splendid gun (one of the best guns, I think, we have had of that size) using the muzzle-dispart, made more accurate practice than the 100-pounder, or even than the 40-pounder; and it is essential that, with any rifled gun, firing elongated shot, the first dropping of the shot should be accurate,

that it should in fact fall at the object and strike the object, because in circumstances of motion at sea there is always of course a certain amount of swell, and then elongated shot, I believe, whether Armstrong's, or Whitworth's, or Scott's, or whosesoever they are, all *ricochet*, I believe, not in a straight line, but, as far as my experience goes, to the right. That of course depends upon the twist given, and, according to the twist generally given to English guns, they *ricochet* to the right at a considerable angle, as much as 45°, so that we do not get the advantage of *ricochet* in elongated shot. It is, therefore, very necessary that you should pay great attention to the rifle sights. Now great attention has been paid to the sights, but, unfortunately, the attention has been paid in the wrong direction. You may smile, but I am not here as a partisan of any particular gun, but merely to point out, what, according to my experience, are the faults of different guns with which I am acquainted. I merely speak from what I have observed, not from any theories. I say that the sights of the Armstrong guns have been graduated to minutes. Those who have used the gun on shore with the close sight—I do not know whether it is in existence now, but it was a beautiful little sight—must know the value of raising the sight to minutes, because you can lay the gun with such extreme accuracy that the minute alteration in the sight makes a corresponding alteration in the range. At a distance of 3,000 yards, I believe, the corresponding alteration is some 5, or 6, or 7 yards. If the gun is correctly laid, the bore of the gun obeys the sights; the difficulty is to get the sight in the right direction. Now this nice graduation, for sea purposes, is of no avail, because you cannot use the close sight at the end of the trigger line. I have shown that a visual error exists by standing at the end of the trigger line, and that this error is increased by the motion of the ship, that is, the liability to error of the captain of the gun not having his eye close down to the points of sight. Under these circumstances, I maintain that it would be very preferable for ordinary sea purposes that there should be none of that minute graduation, but if our tangent-sights were graduated to 5′ it would be quite near enough. Instead of giving attention, then, to this minute division of the tangent scale, I think it would be much preferable if attention was directed to placing the dispart farther out. Now, comparing the 68-pounder and the 100-pounder together in the case of firing over 2,000 yards, the muzzle-dispart in that case is always used for the 68-pounder, as a matter of course. In that case the error of half an inch in the eye of the captain of the gun would make an error with the 68-pounder of 50 yards, but as the 100-pounder and 40-pounder, which are the two guns I compare it with, have not a muzzle dispart, but have only a trunnion-sight, the error with them would be 200 yards, that is to say, about four times as much. So much with reference to the matter of sighting. I think it is such an important matter that it would be well to draw attention to it, even with regard to our smooth-bore guns. There is, as I said, no reason why in our boat's guns there should not be a muzzle-dispart, as there was of old, and with all our guns mounted *en barbette*, as in our gunboats and flush-deck vessels, if the chase guns had a muzzle-dispart, of a very solid nature, that could be shipped and unshipped, or fixed and unfixed on special occasions, if it is not desirable to have it perfectly fixed, I think it might be rendered more feasible by reducing the height of the tangent-box, and in the guns with side sights, I think it would be much more easy to accomplish, and it is a great pity that more attention has not been drawn to it. Having pointed out what I consider the defects which escaped the notice of Captain Fishbourne, I might allude to the small initial velocity, which will in some measure account for the difference of accuracy, with motion, between the Armstrong gun and the smooth-bore. I am not inclined to give that error so much importance as I give to the sights. I believe that the sights will account more for this error, than the small difference in the time of flight along the bore, between the smooth-bore and the Armstrong. As I said before, my experience of the Armstrong has not been so unfavourable as Captain Fishbourne's, except in regard to those one or two little defects, which are all capable of correction, and I have not seen any accidents, except those which I will name. Out of these 4,000 rounds, it would not be surprising if a few accidents did occur, and I do not think a few accidents, unless they are of very great importance, should condemn a gun altogether. I remember being told that a frigate went into Sebastopol with smooth-bore guns, before the Armstrong

was heard of, and that, on her first broadside, one of her guns burst on the main deck. Now that one accident does not condemn the smooth-bores, or condemn cast-iron guns. On two occasions, in firing small Armstrong guns, the vent-piece flew out, in consequence of the breech-screw not being screwed up, from the carlessness of the people using it. Those were the only two cases of the kind, out of the many thousands of shot that were fired. No accident to life or limb occurred; no one was hurt, and nothing of any consequence happened. We lost, I believe, the vent-pieces altogether, but we had new ones, and went on with the firing. Nobody was frightened with the gun afterwards. It evidently arose from want of training. Since, then, a considerable improvement has been made in the shape of the vent-piece, by which its liability to fly out is considerably decreased. Another error which I observed in the younger days of the gun, about three or four years ago, I believe has been repaired in a great measure. It was that sometimes the lead stripped off. That occurred so seldom, that, having fired as many, I should say, as a thousand rounds, I was convinced in my own mind, that the lead never did strip, but subsequent experience shewed me that it would sometimes do so. I suppose that it occurred with older shot that had been long in store, or something of that kind, but I believe that defect has been in a great measure obviated. Of one thing I felt perfectly certain, from the little experience I have had of other guns, that Sir William Armstrong's gun has fulfilled, as far as the bore of the gun could do, all necessary accuracy. The bore of the gun is extremely accurate, but all elongated projectiles have a certain error with reference to sea practice, they will not *ricochet* in the right direction; unfortunately they will *ricochet* to the right, so that you cannot get the benefit of the *ricochet*—an invaluable quality of the smooth-bore guns.

Naval officers, hitherto, have paid little attention to ascertaining distance. They have looked upon it as so subordinate a matter, that, in practice, we seldom know what is the distance of an object at sea. We know roughly within two or three hundred yards up to a certain distance, but beyond, say 2,000 yards, I really do not know how you are to ascertain the distance; so that the advantage of the long range, whether with the Armstrong gun, or any other gun, is, I think, all a myth. I do not believe in it. What we want is a good smashing gun for moderate distances, and whether that good practical gun comes from Armstrong, or Bashley Britten, or Captain Scott, it does not matter to naval officers. For my own part, I should be glad to see my gallant friend, Captain Scott, beat every other inventor out of the field, and all I hope is, that if he does, somebody else will come and beat him out of the field.

Mr. Lancaster: The very able paper with which Captain Fishbourne has favoured the meeting, according to the impression I have received of it, appeared to deal with the two principal subject-matters; first, an inquiry into the material of which a gun could be made, and observations on it; and, secondly, the method of rifling to be employed. To those topics, with your permission Mr. Chairman, I will confine my attention. Much discussion, not only in this Institution but elsewhere, has arisen on the subject of the material of which guns should be composed, and in what method they shall be constructed. It is needless to recapitulate the very able arguments adduced on both sides, but the drawings that have been exhibited to us would seem to shew that gradual experience is determining what should and what should not be the method of constructing a gun. If experience shews, by irrefragible evidence, that in the construction of a particular gun, a particular strain has been omitted to be calculated for, and consequently has not been provided against, you have a step gained in the right direction. Now, I do not think it is any longer matter of doubt that we may describe the built-up gun, as being longitudinally weak, the longitudinal strength of a built-up gun being represented by a cross section of the interior tubes, plus the friction of the exterior tubes. In comparison with a gun whose cross section should be homogeneous and solid, I think it must be held as proved, that a gun so built up must be intrinsically weaker, whatever the other condition of the gun may be. I fear that in the question of the material of which the gun has been composed, sufficient attention has not hitherto been directed to one very important question. Having read with, I believe, the most earnest attention, all the scientific

brochures that have appeared on the construction of artillery, I have never yet seen a proper appreciation of the time in which the work is done. Now, unless we estimate that important element, we can never arrive at the material which should be employed. With your permission, I will shew you a few figures to demonstrate this proposition. I am not now relating any mere opinion of my own, but am referring to facts that have come before my notice, in the services in which I have been engaged in Government matters at the Woolwich Arsenal. Having been called upon by the Government to strengthen some cast-iron guns, and it being a question, in my own mind, as to the proper material which should be employed in the formation of the outer coils, no matter of what form they might be, to strengthen the cast-iron artillery, I had a conversation with the then Assistant-Superintendent of the Royal Arsenal at Woolwich, Mr. Anderson. Various kinds of iron were shewn me, as being very excellent, as employed for outer coils of the Armstrong gun, and possessing the enormous strength of 26 tons to the square inch. I beg you, gentlemen, as scientific men, to remember this, that the instrument by which this iron was tried, was what is termed the tensile machine at Woolwich Arsenal, which exerts its power very slowly, taking, sometimes minutes in the operation. Now, mark the consequence. If this very quality which rendered that iron so very highly resisting to a slow pressure, be used in a gun, for instance, where the pressure is exerted simultaneously, the very qualities that give it resisting power to the slow pressure, are the very worst that you can employ in the gun. Now, what is the consequence here? We have a pressure of 26 tons; this coil was a trapezoid of about 4 inches; we took that bar and nicked it all round with a cold chisel, put it on the anvil, and called a hammerer out of the forge, and told him to give it a strong blow with a 25lb. sledge, Now, how many blows do you think that cube of four inches stood before it broke? You will be surprised when I tell you that it broke at the first blow, like so much cast-iron. Now, we took some wrought iron which represented 19 tons, Welch iron made by Brown and Hughes; we nicked it the same depth as the 26 ton iron; we put it over the anvil, and called in relays of hammerers. We found that it stood 282 blows, and then it did not break, but was merely bent round. This shews the extreme value of testing any iron by percussion, and the extreme danger of relying solely upon a testing machine, and saying that that is the best material for a gun which can be subjected to it. Now, let me give you a further illustration. When these bars were made into a coil and put upon the Armstrong gun, I saw many of them taken off the guns, and put under a steam-hammer. The blow was not given by the steam-hammer as a fair blow, but merely a little tap, and the coil broke into fragments like glass. Does this not explain that sometimes very valuable experiments may result in many failures that are not fairly attributable to the system, by an injudicious choice of material not adapted for the particular purpose? We come also to another particular point, which is this: if you have a bar of iron or a bar of steel, and nick it round in this way, you arrive at a very peculiar proposition. The bar of iron nicked round will stand a vast number of blows; the bar of steel, or a bar of iron wrought up into the condition of steel, breaks immediately, and the value of the proposition, carried out in guns, is this: if you nick a gun by a groove inside, which will put it into the same condition as a bar of steel, and if you have a hard material, like iron very highly wrought, or some kind of steel, you very materially weaken the interior of your gun. Now we come to the question of grooving:—This has been a question very much debated, and many gentlemen of eminent talent have joined in the discussion, and with much propriety have advocated their peculiar views. Time, alone, will shew whether those views are correct or not. But a very little will solve the question beyond all cavil, and it may be done in this way: with every kind of groove, no matter what that groove may be, and when a shot is used that has hard metal projections upon it, whether they be bronze, or cast or wrought iron, if you have a windage between the ball and the bore, the whole bearing of the projectile must come on to the edge of the groove, no matter what the form may be. You have 600lbs weight in a projectile like that, and a windage say, of ·05 or ·06. If you put 50lbs. or 60lbs. of powder behind it, you will have an initial velocity of twelve or fourteen hundred feet. Well, 600lbs. at an initial velocity of 1,200 feet per second, will, in a few rounds, knock the edges of the groove into a cocked hat.

The proof is to be found at Woolwich Arsenal in some competition guns that were fired last year. You see here the seat of the shot, the driving edge of the groove is cut out into a curve; the button in the shot is shunted over to the other side of the groove; there is the re-entering angle, and there you see where the gun burst into fragments. No matter whether the button is of bronze or of zinc, the same result is produced. I had the pleasure of seeing some experiments with that splendid gun, made by Messrs. Krupp for the Russian Government, when I was at St. Petersburgh a little while ago. Here the grooves are very analogous, except that there are two rows of buttons and ten grooves. The gun burst in 50 rounds; prior to bursting, precisely the same effect was produced upon the steel groove with the zinc button on the shell. That is the effect of setting a mass of metal, weighing five or six hundred pounds, in motion at a velocity of 1,200 or 1,400 feet a second; you are certain to destroy the gun; nothing can prevent it if grooved in the ordinary method of angles and edges, having projections on the shot to fit into the grooves.

Mr. Barrass: In continuing the discussion upon Captain Fishbourne's admirable paper, I feel some hesitation in venturing to make any remarks upon such a subject and in such an assembly, but having been interested in observing some ship guns in the batteries of Sebastapol which I found to be on measurement of greater calibre than our then greatest gun, and they were of excellent workmanship, and were also free from mouldings and other abrupt variations of dimensions which are known to be so dangerous to cast-iron objects, and having been disappointed with the results hitherto shown by the wrought-iron guns, I cannot but acknowledge feeling some interest in the subject before the meeting, and that in the hands the subject is now in, something may be done to advance the state of British gunnery. Ten years ago the Russians seemed to be in advance of us, as I believe the Americans are now from the improvements in the systematic preparation of the metal, and the casting of guns with cores and cooling from the inside on the plan of Lieutenant Rodman, and considering the efficient manner in which steel is now manufactured in large masses, and its application to guns on the Continent by Krupp, it is to be feared that the next war will find us as we were, behind even Russia in the application of science to implements of war.

In such an inquiry as the present, as to the best material for the manufacture of guns, it seems to me desirable to endeavour to establish a first principle upon which to base a comparative estimate of the enduring powers of those metals which are eligible for the purpose of making guns.

The first question then that arises will be, what is, or what are the forces that obtain in a gun at the instant of discharge, and what their amount and to what extent, the question of the limited time in which these forces act, may influence and modify the action of those forces, and their consequent result upon the gun.

With respect to the nature of the forces thrown on the gun by the explosion of the powder, it has generally been considered to be one of tension only, but a consideration of the facts of the great amount of work that has been got out of cast-iron guns, and the small amount of work that has hitherto been got out of wrought-iron guns,—making all due allowances for a comparatively new manufacture,—it appears to me, that, seeing a material possessing a high tensile power like wrought-iron, giving practical results, in nothing like the ratio of its tensile power, it is not upon tensile power only that we are to base a comparative estimate of the eligibility of metals for the purpose of making guns, and if the tensile power of metals be not a true criterion for the purpose, the transverse strength will always hold a definite ratio to the tensile power, and therefore the transverse strength can only hold good as a criterion when there is no great disparity between the tensile and compressive powers of the metal; and I think a little reflection will show that the transverse strength of a metal is not a true measure of the eligibility of a metal for a gun, inasmuch as that the gun in firing, is not submitted to the mechanism of the transverse strain, the strain is a direct one, and is either tensive, compressive, or the two combined, and it is to the latter action I am inclined to refer the forces at work in a gun at the moment of discharge. A force requires time for its transmission, and different metals and materials will require more or less time for that

transmission, according to the direct resistance to tension and compression, and if we conceive that in the case of a gun, the tensile force has not had time to pass through the whole thickness of the gun, then there will be a variable tension throughout the thickness which the force has had time to pass, because those fibres which have been longest under tension will be stretched the most, and they will be those of course nearest to the chase; and in like manner if the force, on passing through the thickness, is enlarging an annulus at the radius at which it has arrived, that enlargement will induce an annulus of maximum compression immediately beyond it, and this compressive strain again, like the tensive, being a variable one, through the thickness, it has had time to pass, and is a maximum at the point immediately beyond the annulus of tension, and a minimum at that point where it has not reached, and thus the gun may be considered to be in a state of both compression and tension according to the time of being submitted to the strain, and according to its willingness or unwillingness to have the strains passed through it. If there were plenty of time for the due transmission of the tensile strain as in a hydrostatic proof, then the whole thickness of the gun would, no doubt, be in tension, but if there is not time for this due transmission of strain, (and since the exterior annulus of the gun may not have received any strain at all, and we know that the annulus next to the bore has received a maximum of strain, and consequently of enlargement,) then a mixed strain of tension and compression will be the result, and the resistance of a gun to the explosion of gunpowder will be as the mean tensive and compressive powers of the metal; and it appears to me that it is to such a consideration that we are to attribute the enduring powers of cast-iron guns. A material having a low ratio of tensile power, but that tensile power not being permitted to act by the greater compressive power beyond it, and its consequent unwillingness to pass the strain through the whole thickness of the gun, and permit it all to go into tension. That the question of time, therefore, should be duly admitted in an investigation like the present seems to me clear enough. It was while proving by hydrostatic pressure some wrought-iron girders, and observing, even with the naked eye, the time that was requisite for the forces of compression and tension to pass out of the girder after the load was completely removed, a result I had never observed with cast-iron girders, and no doubt due to the high compressive power of cast-iron, forming a more rigid heel to bring the girder back more quickly to its original position again. In the experiments in the United States also it was found that a weight applied for a short time only, produced no permanent deflection on a bar rested on supports and loaded in the middle, but when the weight was left on all night, an appreciable and considerable permanent set was the result, showing the importance of the influence of time in such considerations. The enlargement of the bore is always most between the charge and the shot, indicating that the maximum disruptive force is just before the inertia of the shot has been overcome, and also where the gun is most heated and acted upon by the incandescent gases, and the proof also that there is a strain of compression as well as of tension by the fissures which often exhibit themselves about this part of the gun, whilst the exterior of the gun has preserved its form and dimensions.

Estimating on this hypothesis, the comparative values of the several metals as a material for the manufacture of guns, we have for the ultimate strength of ordinary cast-iron:—

In compression	92,000 lb.	per square inch.
In tension	19,000 lb.	" "
	111,000	
Giving a mean of	55,500	

And according to the late Woolwich experiments:—

In compression	91,061 lb.	per square inch.
In tension	23,257 lb.	" "
	114,318	
Giving a mean of	57,159	

Ordinary wrought iron :—

In compression	38,000lbs. per square inch
In tension	60,000lbs. „ „
	98,000
Giving a mean of.....	49,000

This, however, is ordinary merchant bar iron. If we had the mean of iron from guns, we should probably find it about the same as cast-iron, but, unfortunately, I have no data. All experiments with wrought-iron from guns having been confined to the tensile strength only. While of the wrought-iron gun forged at the Gospel Oak Iron Works, and which burst at the first discharge, we have no data at all. For steel we have a mean of 120,000lbs; for its resistance to compression and tension are about equal; and this points to it as being the most eligible metal for the manufacture of guns, and as promising a durability double that of wrought-iron for such a purpose. I am not enabled to give the mean of the cast-iron which is used in America, on their improved systems of preparing the metal, and casting with a core, but from the high ratio of the transverse strength, and which was the test to which the bars were submitted, it would appear from the high ratio and the greater durability of the guns that in these processes the tensile strength of the iron is increased without materially impairing the compressile. The resistance to tension by these processes having been increased by 60 per cent., and the durability of the guns from 15 to 30 per cent. The proof bars of the same metal as that from which the guns were cast, I might observe, always bore a higher ratio of transverse strength, than bars cut from the gun after being cast; but this is always the behaviour of cast-iron, the smallest mass arranging itself in closer and more coherent crystals; but this fact remains indisputable, that by submitting the metal to repeated fusions, and keeping it each time for a period in a state of fusion, it is, in a certain measure, decarbonised and purified, and so having its tensile strength increased 60 per cent., as was the case; why the guns did not follow the same ratio of increase of durability as the increase of tensile strength of the metal, the suggestion which I am now making will probably supply the explanation, viz., that the resistance of a gun is not as its tensile strength only, but as its tensile and compressile jointly, and that in increasing the tensile strength of the cast-iron by the process of decarbonisation which I have quoted, the metal approached closer to wrought-iron in its nature, and that as its tensile strength was increased, its compressile strength was decreased, but not in the same ratio, a maximum gain of 30 per cent. being the final result in the durability of the guns, though the tensile strength of the iron was increased 60 per cent., or double that of the durability of the gun.

Continuing the comparison to Bessemer's steel, as introduced by Captain Fishbourne last night, its resistance to compression is 103,255 per square inch, and to tension 111,460 per square inch, giving a total of 214,715, and a mean of 107,357lbs. per square inch, and arranging these results together, we have—

For ordinary cast-iron	55,500
Cast-iron at Woolwich	57,159
Merchant bar for wrought-iron	49,000
Cast-steel	120,000
Bessemer's steel.....	107,357

From which it would follow, that the durability of a cast-steel gun would be double that of a wrought-iron gun. To complete the table it would require us to have the mean from the United States guns of cast-iron, and from our own guns of wrought-iron; and then we would be able to make a complete comparison, and test its value by the results of actual experience; but as far as it can be carried at present, it seems so coincident with actual experience, that I venture to lay it before you, for it has been observed by the officers of the United States, that the densities of the metals were not in the same relation as the tensile strength; and when the mechanical properties of some metals are considered, it would lead us to guard against assuming one property from a metal in the relation of another, and similarly to guard us against assuming the strength of a gun to be in the relation of the transverse strength of

the metal, seeing that the metal in the gun is not submitted to the mechanism of the transverse strain when firing, and also against assuming that the strength of the gun is in the relation of the tensile strength of the metal, if the strain in the gun is *not* wholly a tensile one, which a comparison of the relative durabilities of cast-iron and wrought-iron guns leads one to suspect is the case.

With a view to measuring the forces in a gun during the explosion of the powder, I have thought a series of small pistons, fitting holes drilled from the exterior to the chase of the gun, and at intervals from the chamber to near the muzzle, similarly to the measure pursued by Admiral Dahlgren, might be of considerable service in determining the forces in a gun when discharging, only instead of measuring a relative force as in Admiral Dahlgren's plan, measuring the absolute force by having an index to each piston, the exterior end of the pistons acting on springs like a spring-balance, and which have previously been adjusted. Such instruments could be clamped on the gun, in a manner to compensate for the weakening of the gun by the piston-holes, and every strain due to the several conditions of charging, shotting, windage, and lead-coating the projectiles, could then be ascertained, for considering that ¼oz. of powder when perfectly inclosed in a shell, will exercise a disruptive energy equal to 72 tons, and that when the shot sticks in the gun (as Lancaster's egg-shaped shot did in the Crimea, from the absence of the shot having any means of preserving its longest axis in parallelism with the axis of the gun) bursting is the result. Then it follows that much of the durability of the gun will depend upon the shot being free to leave it on the explosion of the powder, so as to limit the time during which the gun is under strain, and prevent the undue accumulation of force from the incandescent powder. Such an instrument, or series of instruments, would register the variable pressures in the gun from the chamber to the muzzle, and for all the several conditions of charging and loading; for I have an impression that the disruptive force in the gun would not be that due to the charge alone, but mainly due to the shotting, or to a moderate freedom, without windage of the shot, to leave the gun, instead of sticking and compelling the gases to accumulate force, to the injury or probable bursting of the gun.

The two strains of tension and compression in the gun during explosion, being variable in amount, and the tension a maximum at the chase, it would follow that it is a mere question of time when the gun bursts, that metal which offers the greatest mean resistance, offering the least annulus to maximum strain, and making the most endurable gun; and cast steel, in its natural state, seems to offer those desiderata, which are demanded of a good and endurable gun, and to be preferred to any system, however ingenious, of built-up, hooped, bushed, compound, or welded wrought-iron guns.

Touching one point that was raised in discussion last night, Captain Fishbourne's argument, or his mode of illustrating it, was questioned, the observations being associated with the law of the expansion or dilatation of gases. Now, if I understand Captain Fishbourne's argument, he wishes to illustrate a question based upon mechanical considerations only, and represents by the figures in the diagrams the increments of strain that may be added to the gun by rifling, bad rifling, or other unnecessary obstructions, and that, whatever the amount of the obstruction may be, the initial velocity of the shot will be reduced, and the strain upon the gun increased in the same proportion. Now, this to my mind is a very lucid way of putting the question, and shows, that whatever amount of force may be subtracted from the shot, is necessarily, or rather unnecessarily thrown upon the gun; and being a mechanical consideration, it is wholly independent of any physical laws either of dilation or anything else; though it appears to me, that even admitting the law of the expansion of gases, Captain Fishbourne's illustration is as near the mark as anything that could be adopted for illustration, seeing that to accommodate the lead-coated projectiles, a sl w-burning powder has been especially made, for them to fulfil both physically and mechanically, that very condition which Captain Fishbourne's illustrations represent. If the gas was all evolved at once, then the law of the expansion of gases would obtain; but there are several conditions which make the application of this law to the question doubtful, the powder may be quick or slow burning, and of the force of the gas, much will depend upon the freedom of the shot to get out of the

gun as my previous observations have stated. That appears to me so much to the point, and observations mentioning the law of expansion of gases tending to confuse the argument, that I have thought it desirable to name it, though I have no doubtI might have left it in more able—Captain Fishbourne's—hands.

Captain JASPER H. SELWYN, R.N.: Gentlemen, I wish to say a few words on this subject, as one of the bystanders, who has got no gun himself, and may therefore be held to be amongst those who look on and see most of the game. After paying a very deserved tribute of admiration for the elaborate way in which these diagrams have been prepared by Captain Fishbourne, I will ask you to indulge me so far as to banish them from your minds, and let us for a few minutes go back to principles. In the first place it is a most unfortunate thing, that, just as Sir William Armstrong's admirers are lauding the things which we see before us, he has resolved to quit them, and to abandon the whole principle which he has hitherto advocated, adopting a competitive gun, which is not made of coils, but made of steel. Now that is the recognition of a principle which, before the Ordnance Committee, he acknowledged was a correct one. "Steel," he said, "I have no doubt is the best metal for guns; my only doubts are as to its preparation." He, in fact, left it to be inferred that he knew that it could not be prepared, because, had he thought that that was possible, it was evident that it was a better thing for him to do—to expend the unlimited time and money which have been at his disposal, in improving the preparation of a metal, which has a resisting power nearly double that of the best iron which he could hope to obtain, rather than go on finding out how good he could make a bad material. He has now said, "I do think steel can be made," but I was surprised to find that he was the Chairman of a large meeting (in 1859, I believe), before which it was absolutely asserted by one of those best qualified to make such an assertion, Mr. Bessemer, that such a metal could be made, that it had been made in large quantities already, and that, given the time and money, any amount that was required would be forthcoming. Of course it is utterly absurd to say, "Give it me now, this instant, or you cannot give it me at all." That is an argument not worth meeting. With regard to the principle of rifling, which has been so much discussed, it is in vain to tell me that grooves of this or that fashion, hexagonal bores, or elliptical bores, can ever in any way give us a velocity approaching to that of a spherical projectile, having no more windage, where no duty of turning the projectile has to be done. It only remains therefore to ask ourselves, is the velocity a condition, without which you cannot go on, a *sine quâ non?* It is a condition which is of more value than any other in the operations we are called upon to perform? I am afraid I shall not be far wrong if I say that our engineering and artillerist friends from the shore have put before themselves the two qualities of long range, and great accuracy as the only ones to be sought in guns, utterly ignoring the fact that the first qualities for a gun are indestructibility, easy handling, and then the getting out of the projectile the greatest effects. We do not want, I repeat it, to make pretty little round holes, we want to smash iron plates, and he who bases his arguments against the smooth-bore on the fact of its failure to pierce, soft projectiles having been used, is no wiser than the Irishman who forgot to boil the peas in his shoes. You have got for the 68-pounder at last, with a great deal of trouble and trial, hard punches. Hitherto our friends, the artillerists, have been persistent in using much such a fallacy as I should have used, had I attempted to pierce rivet-holes in wrought iron plates with a cast-iron punch. They have at last availed themselves of that which had been offered for a very long time, a perfectly hardened shot, and the result has been seen; the velocity which the smooth-bore could give has had its due effect, and all have understood that there is no earthly difficulty in piercing any plates that we have with the smooth-bore guns, without resorting either to the flat-headed punches, or any form of rifling whatever. But I beg that you will not infer, as was inferred here on the previous occasion, that either I, or those who think with me, advocate the utter abandonment of rifling. No; we say distinctly, give us first the two most valuable qualities—velocity of impact at moderate range, and indestructibility of gun and projectile; after that give us as great a measure of accuracy and as long range as is consistent with those qualities. Now is it difficult to attain this? Has it not already been attained? Is there any question that without the use of lead, without the use of multigrooves,

without the use of any other than very simple forms of grooves, quite a sufficient measure of accuracy can be obtained—quite as much accuracy as is required, not only for all naval purposes, but probably for all land purposes? Yet if our friends, the artillerists, prefer a gun, which is always in hospital for their batteries, we shall be quite willing, I am sure, to permit them to take them, or help to drag them into the batteries, as we hitherto have done, even the very largest sized guns, and we will take the honest old gun which, with a simple form of rifling, on nobody's patent, and made cheaply of good material, will stand any usage to which it can be subjected, firing round shot as the rule, and elongated as the exception. The question of guns now reduces itself into getting the strongest metal, whether that be steel under new processes, or an alloy, such as the Austrians use, the advantages of alloy being that the guns are capable of being re-cast when damaged, which is worth consideration, and which has induced the employment of bronze artillery generally throughout the land service. Mr. Lancaster, I think, has very properly said that no grooves can resist more than a certain amount of wear, which will be not only something less than that which the smooth-bore would stand, for there is not so much work thrown on it; but he must allow me to remind him also that the question of weight comes into play, to destroy, and to make oval the bore of any gun to a certain extent, though not in smooth-bores to so great an extent as in the case of rifled guns, and that in all rifled guns you must expect that, in proportion to the number and fineness of the grooves, will be the ruin to those grooves, and the consequent future inaccuracy of shooting after no great number of rounds; I do not say with slow firing at a mark in target practice, but with such firing as those guns are made to be used for. We do not want to know what a gun will do when it is washed out and greased, and played more tricks with than I can recapitulate at this moment; we want to know what a gun will do when it is subjected to actual service, where it is put, not into the hands of trained gunners, but of the very boys of the ship, who may have to work the gun, for we cannot rely, as the artillery can do for most of their work, on a perfectly trained body of men, but we must occasionally rely on the most untrained and the rawest seamen, and the gun must be of such a character as that in their hands it will still not be an utter failure. Captain Fishbourne has shewed in his paper how the Armstrong has completely failed, but need we ask whether one Armstrong has failed a year ago, or two years ago, or three years ago, or whether the last and newest pattern has failed; if we once acknowledge that the system of lead-coating of shot is wrong from beginning to end, and not necessary; and, secondly, that the system of building up with weak metal when you can get a strong one, is wrong and not necessary; that, thirdly, the system of coiling guns never gives you a perfect weld; that by no possibility can any gun, welded or put together on the Armstrong principle, shew a perfect weld between its coils, for the scale, which evidently takes place from the oxide between the coils when they are wrapped round the mandril, never is and never can be taken out with certainty, though not visible when the gun is finished. We have not got, though I hope Mr. Bessemer will furnish us with it, steel of such a size and such a quality as to enable us to get our guns cast and bored, which is the very cheapest way of making them, or cast with a central core, cooling from the interior, perfect or nearly perfect as the Rodman gun. If we have not got that, we have got steel for hoops and for tubes, and I maintain it is very great folly to resort to a metal, like wrought iron, which is said to have an *enormous* tensile strength when it reaches 26 tons, when we can get another metal without difficulty which bears something like 56 tons. It is true that under certain conditions that metal will fail to support impact conducted in the way which Mr. Lancaster described; but with Mr. Barrass I perfectly agree, that that is by no means, or in any way, the strain to which the metal in the gun is subjected, that being entirely a compound of tensile strain and compressive force acting together. I have no doubt that Mr. Barrass is aware that Professor Barlow and Mr. Longridge went fully into the state of the metal in the guns, and the way in which each particular layer or annulus supports the strain.

Mr. Barrass: And Mr. Mallett.

Captain Selwyn: And Mr. Mallett. But I think the mathematical demonstrations, the early ones, were due to Mr. Barlow and Mr. Longridge. Those being the

circumstances, we have not to ask whether we shall now continue to build up the guns on the Armstrong principle. I do not ask whether they shall be altered, whether this hole shall be filled up to-day, or that hole to-morrow; whether a provision shall be made for the issue of gas, which seems to mean nothing less than the blowing off the breech, or whether the shot shall be coated with bronze instead of lead, whose galvanic action may be a little less rapid, but is nevertheless certain. No one, I am sure, can see that terribly diseased shot (pointing to diagram of exfoliated lead-coated shot), without feeling that electricity does mean something, and that it is not safe to expose such shot to the action of bilge water and salt water if they are affected in that way when in store in Woolwich Arsenal. If, then, these guns are defective in principle, if their shot are also defective in principle, to what are we to turn? Why did our ancestors, having tried rifling, for it was not unknown to them, give up these advantages, which were also known to them, and come back to the smooth-bore? Simply because they found that, given the wear of the guns, given the various inconveniences of loading, the diminished weight of shot, the want of accuracy of *ricochet* firing, which is no small matter as regards naval work—given all these and other things put together—they not being then aware of any system of rifling and strength of metal by which the use of round shot could be combined with it—they decided to give up rifling altogether, and to revert to the smooth-bore, and I do say that it is not wise to conclude that we are so advanced in science, and so well-informed, as that our ancestors must necessarily have been fools. We sometimes hear it said, "Oh, they knew nothing!" but they knew a great deal, many of them, and we have forgotten a great many things that they knew. And so it happens every day. We shall yet come to the adoption of rifling as the exception, and smooth-bores as the rule, for all natures of gun; nor will the 1,600 feet in a second initial velocity, which the smooth-bore now reaches, be by any means the limit of initial velocity, when we come to larger guns properly constructed; and if that be so, what armour-plate, what possible resisting structure, that you can put on the ocean, will avail against such guns, loaded with steel shot, which piercing the side, will make langridge of your own armour plates? I advert shortly to that, because I hope still further to bring forward the subject in a short time, and to shew you that we should not spend half a million from time to time in making experiments, which the next day demonstrates to be thoroughly useless.

Rear-Admiral HALSTED: I only desire to make a few observations. We were addressed by a gentleman who styled himself a seaman-gunner, though not, of course, in disparagement of his position as a naval officer. Now, all that he described to us was simply and absolutely target practice, although the number of rounds amounted to 4,000. Now, I am ready to contend that target practice is but a means to an end, and that the end of the practice when perfected is really to meet an enemy, to fight a gun in action; therefore, I cannot understand how any target practice could overthrow the results read so clearly and distinctly to us last night, of the very first action in which those guns were actually tried. I cannot understand how he could overturn those results, or maintain that those accounts could not have been correct, in consequence of his own experience of what the gun had done, when he was at target practice with it. There is another point on which I would wish to say a few words. If the gun was to be made as perfect as possible to-morrow morning, what could it do? It is a gun which we are endeavouring to apply to use now; and the whole of our object and purpose in using the gun is to use it against armour-ships. Now, if it were as perfect as it can be made, it can but make an indentation to the extent of an inch and six-tenths in armour-plates. You may fire from it any shot, be they steel or gold, if you like, but that is the power of the gun. I say it is utterly impotent and powerless.

A MEMBER: Which gun?

Admiral HALSTED: I am speaking of the 110-pounder. And still more so as regards the gun which fires a shot of 70 lbs., with a 9 lb. charge; and still more impotent again is the other naval gun which we have been blessed with by our artillery friends, which fires a 40 lb. shot with a 5 lb. charge. It is literally and truly childish thus to arm the navy; if it was not very cruel, it would be ridiculous. With regard to my friend, Captain Selwyn's, observations about the steel round shot fired at

Portsmouth, I must solemnly protest against them. I make this plain statement, that any experiment which is made under conditions where you have not a single true representation of what a gun will have to meet when it comes to be proved in action, does not deserve to be called an experiment; or it should be called a false experiment, and it is not only false, but treacherous, absolutely treacherous. Now, the steel shot fired at Portsmouth were fired, not at a proved plate, but at an unproved plate, fixed temporarily upon the sides of an old ship.

Captain SELWYN: Pardon me, I did not refer alone to the Portsmouth experiments. You are quite aware that there are other and very important experiments, so to call them, which have been tried in America. The "Keokuk" was pierced by such balls.

Admiral HALSTED: My observations will still apply, for another reason which I will specify in a moment. Now, we know that in the year 1847 or 1848 there sat continuously a Committee of the House of Commons, upon the Ordnance and Navy Estimates. It produced a very valuable mass of Reports; and the Chairman of that Committee was the present First Lord of the Admiralty, the Duke of Somerset, then Lord Seymour. Now, on investigating minutely the account of the ages of wooden ships, it was found that at the age of 37 years, a wooden line-of-battle ship or frigate departs this life, and some other ship takes its place. Now, the old ship we have been firing upon at Portsmouth is 33 years old; she has very nearly arrived at her three score years and ten, and how many sound ribs she has, mercy knows. But again I refer to a statement that was made, and I am very glad that it was made, for I hardly would have believed that such a thing could have been done, if it had not been stated by Captain Heath yesterday evening. The new rifled gun known as Admiral Frederick's gun, the 7-inch gun of 6 tons 13 cwt., is now being sent to Portsmouth, to be fired at plates of some sort, I care not what sort, to be fixed upon the side of a ship, an old hulk, called the "America," built just 54 years ago, in the year 1810. Now, mark my words, because I wish to make a prophecy. In about ten days or a fortnight when this gun shall be ready, there will appear in all the professional puffing papers, and no doubt especially the *Times*, a wonderful account of what this gun has done; and we shall be told that it has pierced the old "America." Now, that would be in itself ludicrous. But the serious matter is, that the whole country will be told, that what it could do then, it could do also against the true, firm, new armour-ships, which, if it is ever fired at all in anger, it will have to meet. And not only that, but who will have to stand the brunt of the difference, which then inevitably must take place, between the performances of a gun when in true action and when at a false experiment? 70,000 seamen and officers of the navy will be held up to the country as incapable of fighting a true and successful action with the most wonderful of guns. It will be said, "see how those guns exploded and destroyed the 'America,' why cannot they do the same with the 'Gloire' or the 'Pervenetz,' or the armour-plated ships of other nations?" I solemnly protest against it; I solemnly protest that if any attempt is made to prove guns of any description intended to fight armour-ships, unless against true and absolute representations of armour-ships, unless the guns are fired not merely directly, almost as by an instrument at right angles to the surface of the target, but under all those circumstances of varying position, and varying distances, in which an action must be carried on—I say those who attempt to force our confidence in such weapons, only tried against such things as the "America," and who refuse to try them before real representations of what they will have to be proved by when the flag of the country is flying over them.—I say if they persist, as they seem to intend to persist, in doing so, they will do that which I will not here trust myself to describe.

Commander SCOTT, R.N.: Will you allow me to make a few remarks about these guns. First, I would advert to what Captain Dawson has said. Of course he spoke as a naval gunnery officer exercising trained men. He says, attention has been drawn in the wrong direction; there, I quite agree with him. With respect to the Armstrong 110-pounders, the muzzle nips of which, he says, have been ground out, I think there are about 700 of these guns in the service, and I am not aware that the nips of three of them have been yet ground out. Captain Dawson has told us of

his experience in target practice; I think it right to mention my experience in target practice also. It is only a short time since, at Newhaven, that they were firing the 110-pounder gun; and every time it was fired where do you think the people who were looking on went to? Why to a considerable distance. I went into a ploughed field behind, at an angle 200 yards to the rear; and I saw every other person shy the gun just in the same way. If you look at the chamber, you will observe there is room for a powder charge of 14 lbs.; it is said that the charge the gun was constructed for was 16 lbs. It was found that the charge of 14 lbs. tore the gun to pieces, and heated the bore much too rapidly, and consequently the charge was reduced to 12 lbs. Now, as you observe in the diagram, the charge of 12 lbs. does not fill the bore; and the result at Newhaven was, that if the charge was kept back to save the vent piece, the shock against the shell caused it to explode either *in* the gun or *at* the muzzle. Speaking from memory, I should say, five or six of these shells in succession exploded on one occasion at the muzzle of the gun; and at length, one or two of the shells burst in the gun itself, and cut up the rifling. When the cartridge was pushed forwards, close against the projectile, the result was to split the vent-piece. There were three or four vent-pieces split in the rounds that were fired. They continued to use 12 lbs. of powder, and to my astonishment I observed the vent-piece got fixed tight in the gun, requiring the efforts of five or six stout artillerymen ramming a long pole against it to drive it back. This occurred two or three times. Then it was said to the gunner, "you didn't put the tin cups in properly." I looked myself, and saw that the gun was expanded in the bore, and that the tin cups got thus pushed back over the vent-piece. I took up several cups, and found that they had been set back over the nozzle of the vent-piece. Now, supposing that had occurred in action, when the gun was warm, the vent-piece would have stuck, and who would have thought that the bore of the gun was expanded, and that there was a tin cup nipped in this way over the vent-piece? What Captain Fishbourne has said about the accidents which occurred in action at Kagosima, is similar to what occurred at Newhaven. As to the stripping of the shot; one shot that was fired tumbled just over the hill, and fell five or six hundred yards off, and several shots stripped—the lead on one occasion going away to the extreme right, close to the haystack where a policeman was, and on another occasion going more than a mile to the left, against the coast-guard chimney-pots. After this I observed there were lead globules rolling along the bottom of the bore, and had the gun been allowed to cool without cleaning, those lead globules would have stuck fast in the grooves, and the gun would not have hit a haystack. Without dwelling upon that further, I may say it was after this experience with the 110-pounder, and its muzzle-nip at Newhaven, that the grip of the muzzle was ordered to be cut away. I now wish to call your attention to the form of Sir W. Armstrong's grooves, which had originally two sharp corners; but as he drives the shot on one side only, the other acted merely as a trap to catch the lead. The specimen here is not his original groove, for it is rounded out just as my groove is. Well, you have had the muzzle-nip, and the stoppage occasioned by it in the gun was so great that when cut off, and thus shortened one foot, the gun gives about the same range as before. There is one fact that I would mention about that grip, because you hear many wonderful things about the Armstrong gun I heard Sir William explain that his shot actually obtained in the air a longer flight than was due to the same shot fired *in vacuo*. He said it floated upwards like a kite. But the fact is, that the shot, after passing the breech-nip, drops down and keeps along the lower part of the bore until it comes to the muzzle-nip, which throws it upwards. So he gets 6" more elevation in the 12-pounder from the jump of the shot upwards than the line of the gun indicates. That is why the range in the field is actually greater at very low elevations than it would be *in vacuo*. You observe in this model where the breach-nip is. The shot is pushed in tightly against it, and is held there by the lead at the rear. The object of the grip is to keep the shot centred in the bore. If that grip were continued the whole way, it would have the intended effect; but now, directly after the shot has passed that nip, by which such a heavy strain is thrown on the gun, it is let down again into the lower part of the bore, and is then in the same position that it would have been without any

grip at all. If the breech nip were ground out as well as the muzzle-nip, you would get 10 per cent. additional initial velocity, and the life of the gun would be very much increased, and the vent-piece probably would stand. The nip in the shunt-gun is similar in its effects. Passing on, however, from these and other points in connection with these guns, which Captain Fishbourne has so admirably touched upon, that I need not further call your attention to them, let me come to what Mr. Lancaster has stated of the grooves breaking through, on their driving sides. Here is the 120-pounder shunt-gun of which we have heard so much. It was the one that was fired at Thorneycroft's bars, and was stated in *The Times* to have fired through plates of five, six, and seven inches thickness. But they were mere bars. The fractures in this gun are at the deep part of the grooves, not the bearing side. The pull of the shot is what cracked the inner tube through, which, although worn where the shot took the nip, is cracked at the opposite sides. If you take this 300-pounder shunt-gun, that again would go through the sharp angles on the loading bearing of the rifling. Now, in the early groove which I had for a light gun, I had this side sloped away, because I did not require great turning power for light shot in loading, but only a good bearing for the shot in coming out. But in the groove I have now got for the 100-pounder—the first was a 40-pounder—I require the groove merely to turn the shot in going home, and the loading side of my groove is just deep enough to do that. It is ·07 only, but the bearing side is one-eighth of an inch deep, just as you see in this muzzle of my 300-pounder. Both the shunt-gun and this are twice the full size; and in this 300-pounder only one-half the surface of the gun is taken out that there is in the shunt. Moreover, Mr. Anderson's experiments completely confirm what I now show as to requiring fewer grooves, for two of my grooves, given as you see in the Report of the Ordnance Parliamentary Committee, bear rather more strain than three of the shunt. I now beg to call your attention to this Table. When the guns mentioned below were put into competition, they had fired as given in the Ordnance Select Committee's Tables:—

Scott	300
Britten	263
Lancaster	138
Haddan	63
Jeffery	51

Some of these guns therefore had fired six times as many rounds as others with elongated projectiles. I do not want to dwell upon the amount of accuracy, but merely upon the fact that after the guns had fired 57 rounds in competition, two of them, Mr. Britten's and Mr. Lancaster's, were taken and slung up, and thus completed a large number of rounds, so that instead of bearing the strain which they would have had to bear in service; it was probably one-third less, and therefore much within the limit of the strength of cast-iron. I wish in the next place to call your attention to another Table, a very remarkable one, which Captain Fishbourne has given us. It shows the initial velocities with a charge $\frac{1}{10}$th the weight of the rifled projectiles. You will see that Bashley Britten's is 1213 feet, and the Armstrong 40-pounder, his longest gun—the gun that is said to give the best range—is only 1081 feet. What a remarkable difference with $\frac{1}{10}$th! What is that due to? To that constriction in the bore, and that constriction at the muzzle, and the excessive friction in the bore—and nothing else. In the other Table you come to the Armstrong 600-pounder shunt. The velocity given with a 610lb. shot, was only 1172 feet. The weight of the projectile in that case was eight times, and $\frac{5}{7}$ths the powder charge; I consider that a most valuable Table. The windage in this gun, however, is so small, only ·04, that if you were to take a hammer and flatten one of the studs on the projectile, no man could load with it. When the 300-pounder was last fired against the "Warrior" target, the studs stuck each time, and they could not get the shot home. When it came near the end of the bore, the shot could not pass the contraction there; at least they said the cause of the fracture of the shell was, that it was not close home against the powder. What a gun to load in action in a hurry! Well, if you cannot get the ball of a rifled gun home, then you must

take to the smooth-bore again. Haddon's, one of the cast-iron guns, gave a velocity of 1277, with a strength of powder of 1170. His windage was ·17, the weight of the projectile 7⅔ths that of the powder. The 600-pounder shunt-gun gave two feet less velocity. The windage was ·04, and its projectile in proportion to its powder charge, was lighter considerably. The Parrott gun shows a much more marked difference, 1405 feet velocity, with a nearly closed windage. With respect to the 600-pounder, also, we know that in a gun of that vast size, there is much more heat evolved, and heat is a powerful agent in expanding the gas of the gunpowder. Therefore, with that large sized bore of great powder charge, we ought to have much higher velocity. Why do we not get it? It is not necessary for me to go into the principle of these studs, to show why they wear down, and why Sir William has taken the form of the French stud. When the shot presses against the groove, as it must do in going along it, the stud wears away, and the consequence of the giving way of the fore part of the stud is, that the shot is always at a slight angle to the axis of the bore in travelling through the gun. Hence part of the effect communicated by the charge is in reality expended in wearing away the studs, instead of propelling the shot. I have to call your attention to one figure more. In 1862, the shunt 70-pounder, which was called the naval muzzle loading gun, was tried at Shoeburyness. I have shown you that my cast-iron gun was considered in a sufficiently good state to be put into competition after 300 rounds, firing iron shot with soft metal in front, though in reality nearly all the rounds were obtained without any soft metal in front, because the old shot were picked up off the sand, and fired over and over again. There were only about fifty shot used, and with them the gun fired the fifty rounds. You will see with what accuracy, in the Table at 2° of elevation, as compared with Mr. Britten's, and again at 5° of elevation, as compared with Mr. Britten's at the same elevation. But I wish to call your attention to Mr. Bashley Britten's, in November, 1859, when he had just commenced firing, and in August, 1861, after he had fired a great number of rounds, and you will see there is a marked difference. His gun had greatly fallen off in accuracy; but the 70-pounder shunt-gun only fired 283 rounds, and was then unserviceable. It was expanded at the breech-plug, so that the fire hung round and its grooves were considerably worn down. This gun had six grooves. Now, what was the cause of this? There was the soft metal; but there was just the same work taking place that I have already explained; and the gun, although an expensive wrought-iron gun, was rendered unserviceable after a small number of rounds.

Rear-Admiral Sir FREDERICK NICOLSON, Bart., C.B.: May I ask Captain Scott a question—that is, if the experiments alluded to at Newhaven, were experiments against an earthwork battery?

Commander SCOTT: Yes.

Sir FREDERICK NICOLSON: I should like to say a few words—I will not detain the meeting more than two or three minutes. With reference to what happened to me in regard to an account that I obtained about those experiments. I was one day going to the train, rather in a hurry, when I met an officer who has taken the deepest interest in gunnery matters, in fact, it was Captain Scott himself. I saw that something serious had occurred. He asked with a very gloomy face if I had heard what had occurred at Newhaven; I replied that I had not. He then described what he has described to you this evening, with reference to the great misfortunes that had happened to the Armstrong guns. I had not much time to go further into the subject, and I went away to the train, feeling great regret that the gun at last had been entirely put on one side, knowing well that there were a great many guns of the kind made, and that a large sum had been spent in making them. However, when I got into the carriage, singularly enough, the first question I was asked was—"Have you heard of the experiments at Newhaven?" I said I certainly had. The gentleman who asked me the question, an officer of the Royal Engineers, then said that nothing could exceed the success of those experiments, that the practice of the gun was perfect, and the demolition of the battery something remarkable. He said, that no gun he had ever seen or heard of, could have breached that battery as it was breached by the Armstrong guns. In fact, he showed me a photograph of the battery itself. I said, "surely the Armstrong gun has been lamentably damaged, is

there not some elongation of the inner tube?" And I asked some questions, in order to elicit whether all those dreadful mishaps had really taken place. All I can say is, he assured me that he was present, and that he had seen nothing of the kind; that whatever had happened of that kind had certainly not come under his observation, though he was there with others for the express purpose of testing the gun. I thought that this was an illustration of how frequently on the trials of these guns we find that different observers are very apt to look at different sides of the shield.

Commander SCOTT: I should like to say one word or two in reference to the remarks of Sir Frederick Nicolson. I have had so little hesitation on the subject, that I have sent in my report to the authorities. One does not like to mention names, but I assert most positively, and nobody can contradict it, that these things did take place, that the inner tube protruded and expanded both ways after the firing (which I did not mention), and that there was a considerable leakage of gas, and that I did not mention. Several means were suggested of filling up the powder chamber, so as to prevent the fracture of the vent-pieces at one end, or damage the shell at the other. It was impossible to make a mistake. The shells were continually breaking up. It is true that with a large bursting charge the Armstrong shell did, wherever it hit, cut up the ground. Who could doubt that such a result would take place with a large elongated shell? But what of these general assertions about the gun being superior to any gun in the world? Captain Dawson, commenced by saying that he had no other experience of other guns; and then said that the Armstrong is the very best gun. This is what other people tell us; but they have not had experience; and they do not know what a rifled gun should do. So completely are some in love with this gun, that they cannot understand that there can be any other; and it is true that there is no other, for they have never allowed any other to be brought forward.

Commander SYMONDS, R.N.: There is one observation I should be sorry not to make at this meeting. I have observed that one gun, which has played a most conspicuous part of late years, has been totally ignored in the course of the discussion. It is a gun which has not only stood a very good test, the commercial test, having been advertised at a certain price to do a certain amount of work, and having been sold to the extent of some hundreds, I believe, to all the powers in the world, but it has also played a most conspicuous part in the operations in America. That gun happens to be a built up gun, though built up with steel; and I am quite satisfied of this, that only one motive, which I know all of you will appreciate, has prevented the gentleman who makes those guns from coming forward to-night. If you will permit me, I will offer a suggestion—that he should be asked to recount to you some of the most interesting information of which he is in possession, from those who have used the gun in America. I allude to Captain Blakely. I can speak with certainty on this point, that the gun has rendered good service there—no matter on which side—having produced effects on the turret ships which no other gun has produced, with (as I think my friend, Captain Selwyn, observed) steel spherical shot; and I think it is a gun which, in a discussion of this sort, ought not to be lost sight of. You will excuse my going further into the subject, as I do not pretend to be well up in the gun in question, but I thought it right to bring it to your attention this evening.

Captain BLAKELY: If it would be of any interest to the meeting to hear a few words on the practical side of the question, I can only say, having made a great number of guns, that I coincide with many of the opinions which Captain Fishbourne has arrived at theoretically. For instance, I find a great advantage on some occasions in using powder to burn in such a manner that the shock does not come very abruptly, the pressure of the powder being continued very much in the way Captain Fishbourne represents in the first column. The way in which I do this is to place a small air chamber behind the charge of powder; I think that is preferable to elongating the cartridge, or using a very slow-burning powder, because if we use a slow-burning powder we are obliged to use a large quantity; the Russian powder, for instance, requires exactly double the weight of ordinary powder to produce the same effect. With an elongated cartridge again there is a great

strain upon the gun immediately behind the shot, and there is a lodgment formed there, which eventually ends in rupture, I therefore put the cavity, the air space, behind the cartridge. Within the last few days I have received favourable accounts of the performances of guns so arranged, which have been tried on a very large scale. The bore is 13 inches in diameter, and the gun fires 650 lb. shot with 55 lbs. of powder. One word about rifling. It is generally supposed that the driving surface of the grooves must be worn out. That depends upon the size of that surface. If the surface is large enough to bear the pressure, little wear will take place. It is a mere question of surface. I may be allowed to criticise one thing about Captain Scott's system of rifling. You will observe, no matter whether the shot may be large and bearing upon one point, or whether it is small, there is only one line bearing, that is a very small surface, so small that it must eventually wear. I have rifled a great number of guns with Captain Scott's permission, using this curve for the purpose of centring the shot; but I have added to that, first of all, a radial surface, which will always give a large bearing surface, to turn the shot, and then I have Captain Scott's curve to bring the shot into the centre. In the shunt system, Sir William Armstrong brings the shot into the centre of the gun, and makes the axis of the shot coincide with the axis of the cannon, by ripping several, I believe fifty studs of copper. Now, I fancy that must be an exertion very much greater than is necessary for so small a purpose. In the shot, weighing no less than 650 lbs., and of which this is a model, I effected the same purpose in a different way. I had a radial bearing surface for turning the shot, and I then added an inclined surface for the purpose of making it slide into the centre of the gun. Though I gave a rather large surface of pretty hard bronze to turn this shot, I made simply a few copper nails do the work of bringing the shot into the centre of the bore; and I found that that was quite sufficient. There were eight copper nails, and the upsetting of these eight nails was sufficient to lift the shot and put it in. 650 lbs. was all the force that was necessary; and 650 lbs. could easily be applied by a small piece of copper. I quite agree with Captain Fishbourne also as to the great facility of rifling guns in such a manner that they can fire round shot. In fact, I scarcely ever manufacture any guns where I do not employ round shot. I see on the table a specimen of a 100 lb. steel shot made by me. I will not discuss any question not raised by the author of the paper, but I cannot sit down without remarking that the system of rifling we adopt, the kind of powder, and material of the gun and shot, are of very little importance, in fact, no more important than the colour we paint the guns. The only real question of importance is the size and power of the guns we are to use. If the British navy persists in refusing to use any guns above the power of 68-pounders, which is the most powerful gun at present in the English navy, the ships so armed will be impotent against the navies of almost every other country in the world.

Mr Reynolds: I think there is a light in which the subject of material has not been considered, at least, I have seen no record of any discussion in which it was looked at from the point of view I am about to take. It is well known to engineers, and always taken into account in selecting materials, that some irons are more extensible than others, and generally the more extensible material has less original tensile strength. I have no doubt that the particular iron—made, I believe, by Messrs Taylor of Leeds—which was used for the coils of the Armstrong guns, although possessing considerable tensile strength—probably fully 24 tons to the inch—was not iron that would bend as freely after nicking, or bear stretching when cold to as large an amount, as a softer and weaker iron; but it does not therefore follow that it was an unsuitable material for hooping guns. For other purposes these qualities may be highly desirable, for such engineering purposes, for instance, as the chains of a suspension bridge. The strength of Chelsea bridge has been a matter of much discussion. I happen to know that the excellent iron of which those chains are made will bear from 23 to 24 tons per square inch, and stretch cold nearly 20 per cent before breaking. For such a purpose this is a most valuable quality, but it does not follow that it is so for guns. The material, with the manufacture of which I am at present most connected, is steel, and it may be worth while to note the direction in which manufacturers, some at least, are turning their attention in pro-

ducing steel for guns. In the establishment with which I am connected, all the steel used for any special purpose of that sort is tested, not only for tensile strength, though that is of importance—not that tests made by the machine at Woolwich, if it is not altered since I had a knowledge of it, would be of any value whatever, because the specimens operated upon were too short—but it is tested also for transverse strength and resistance to impact; and this is done on an extensive scale, taking a piece the size of a railway axle, say four inches in diameter, and testing it by a succession of blows with a drop of 14 cwt., which has a range of 40 feet. After each blow, the specimen, if bent, is reversed, so as to have a succession of flexures in opposite directions, the sum of which is taken for each separate material, of which the composition, specific gravity, &c., are registered; the amount of endurance is thus thoroughly ascertained. But it does not follow that the material which will do the highest duty under these severe tests is any the more suitable for guns. It seems to me—and it is a matter upon which we are now going to make further experiments—that what we want is the material that will carry the highest tensile strain through the greatest space without taking a permanent set. The amount of work that may be done by a bar of soft iron in stretching, the number of tons per square inch that it takes to stretch it, multiplied by the whole distance through which it moves before it ultimately breaks, may possibly be greater than that of the very best quality of steel; but when it has taken a permanent set it is useless for guns. I am told that the iron hoops, with which the Armstrong guns have been cased, have become loose; that is the result of using an easily extensible iron. It must be admitted that there is less danger to the gunners if the material will stretch in that way instead of breaking, but the gun for all practical purposes is destroyed. An illustration of the fact that the endurance of a material not extensible and not capable of flexure in the sense of permanent set, may be the most suitable for the purpose, may be seen in a sword-blade. In its normal state of soft steel, it will bear only a very limited amount of flexure without taking a set; but after being hardened and tempered, which would reduce its power of bearing permanent extension, it will not only require a greater force to bend it, but it may be bent double without having suffered any injury, as far as we know, and recover its form perfectly; and it will bear that test over and over again. It seems to me that the direction in which Captain Blakely, Mr. Anderson, and others, are going, is right so far; they are making the inner tubes of the guns of steel; and the great object of experiment should be, to find that quality of steel which, without taking any permanent set and without fracture, will bear a high strain through the greatest distance. I would merely mention that we (the firm of Naylor, Vickers, and Co., of Sheffield) are organising a series of experiments to ascertain that particular point.

Admiral Sir GEORGE SARTORIUS: An observation was made by Admiral Halsted that the vessel upon which some experiments were made was a very old vessel. Now he must remember that vessels are constantly repaired, and that a vessel may be 50 or 60 years old, and at the same time the timber be very good and strong; so that according to the effect produced upon the timber, you may very fairly judge what will be the result in action. With regard to distance, we must remember that no naval action has been decided, or can be decided at a distance of more than 1,000, or say 1,200 yards—much more frequently it is within 400 or 500 yards; therefore, extreme range and extreme precision are not necessary in naval actions. It is true there may be circumstances, for instance, in combined operations, as in covering troops and landing boats, when a gun that has a great range may be necessary, and will be necessary no doubt, but the gun for use in naval warfare is such a one as has been described more cleverly than I could do by Captain Selwyn, who has anticipated me in some of my remarks. The gun that we require is a gun that will make the greatest hole with the greatest number of splinters, and carry from 1,000 to 1,200 yards. That is the gun that we require, and that we must beg those gentlemen who are gun makers to give us. Give us that gun, and depend upon it, we shall do as well as our forefathers did.

Captain FISHBOURNE: I will first refer to the observations of my friend, Captain Dawson. He commenced with finding fault with what I did not say; but having exhausted your patience, I could not introduce other matters. I was dealing

rather with principles than with mere details. But I objected to the sights on a former occasion, and I stated in general terms, what Captain Dawson has done in detail, while he said he was advocating the multigroove system he supplied particulars as to defects which I had not touched upon. He then alluded to "theorists," meaning to say, that his facts were reliable facts, I suppose because he saw them, and implying that mine were mere theories. Well, I gave a number of facts on the authority of other people. Any man who has ever been under fire, must know that not one man in a thousand is cool on first entering fire; and it is not as Lord Byron says, until his ear gets more accustomed, and less nice, that he acquires that absence of excitement which will enable him to use with certainty, complicated arrangements in guns; therefore, the normal condition of coming under fire being that of excitement, the multigroove gun, from its complication, is utterly unfitted for the general purposes of warfare. He says, that I said that everybody agreed in the condemnation of the multigroove. I did not say that, but I *believe* that every one, himself included, condemns the multigroove, though he is reluctant to say so. But I need not enter into that question, for the inventor has given it up; and all that is left us, are a few little nicknacks, as the small change of our three millions of money. Captain Dawson said that I had proved too much. Well, I do not know what he means. "Too much" has two significations. I am quite aware that for the admirers of Armstrong's guns, I have proved a great deal "too much." I do not know precisely whether he means that, but if he does not mean that, instead of going into matters not mentioned in the paper, it was his business to show this meeting, where I had proved too much, and how I had done so, he was bound to support his assertion, but he has not attempted to do so; he has not shewn a single point where I have exceeded in any way, facts, or reason, or figures. Tables have been framed to prove the inferiority of the smooth-bore. Allow me, also, the run of the multiplication table, without limitation of law or reason, and I will give any amount of such facts. Such is their character, that when we come to winnow them we find there is one fact among a number of fancies. With regard to Mr. Lancaster's remarks, I quite feel with him, that *time* has been utterly ignored in all these questions, and that the disruption of these guns has been, because time has been lost sight of, and what has been claimed as an advantage, has been really a disadvantage. With respect to a remark of Captain Blakely's, I dare say it was a *lapsus*, he said it did not matter with respect to rifling what the grooving was, any more than the colour of the gun. I must take exception to that, as it is quite clear that the multigroove gun is in process of disintegration from the very first moment of proof, because it is subjected to a degree of pressure, that the metal is not capable of bearing. It is established that the use or disuse of that system of grooving, is of very material consequence, and that it is most important that it should be abandoned as wrong in principle. Why I dwell on it now is not so much in respect to the past, as the future. I understand—which is a proof of the fact that I mentioned, but which Captain Heath controverted—that the authorities have come to the conclusion that this multigroove gun has been subjected to too great a tension, and have determined to reduce the charge and the size of the chamber. Now, what will take place? Just what is taking place now. Experiment has established, that if powder is burnt in a closed vessel equal to its own volume, the chamber or vessel containing it, is subjected to a pressure of 90 tons to the square inch. Reduce the charge (within certain limits) and contract the chamber equally, and the same conditions will obtain. As long as a shot is used that offers the same obstruction as in the multigroove, and closes up the chamber, there will be the same amount of initial tension, and the same destructive energy exercised upon the chamber, vent-piece, &c. Common sense would dictate, that if the gun will bear such a tension, its strength should be made available for the purpose of projecting the shot with greater velocity, making it what it is not now—effective against iron-plates. I have put the tension at 18 tons, as the chambers break up and crush the metal, and 17 tons is the pressure at which this action occurs. Sir William Armstrong gives it as his experience, and he states it calmly, that if he subjects his gun to a pressure that would give the shot initial velocity exceeding 1,200 feet, the metal yields. Does Captain Dawson believe this? Is Sir William Armstrong ignorant on

this point? If so, an Appendix to the Queen's Regulations recognises that fissures and flaws in these guns is their normal condition. I suppose gentlemen conversant with the subject would tell us that that is not the normal condition of metal. Look at that shot on the table, look at the metal that we see every day in machinery is that full of flaws? Do they not cast aside articles with flaws as defective? but here they are recognised as inevitable, as matters of course. Every gun comes out not with a bill of health, but with a long bill of defects; and there is a person appointed, I know not of what rank, for the purpose of taking a list of defects of every new gun. From its birth, the multigroove is in process of disintegration, and the Table which I gave in proof of the very high tension is very important; I dwell upon it because Captain Heath implied that it was empirical. It is to a certain extent empirical, but every one knows that it is very common to use empirical, as stepping-stones to accurate formulæ. There is an anecdote about Sir Astley Cooper, that you may remember; some one once charged him with being unchemical in his compounds. "Well," he said, "I do not mind being unchemical, if I can save my patient." Now, I want to save the patient, John Bull, from the infliction of another three million blister; and if I effect that, I do not mind being charged with being empirical. There is the fact admitted by Sir Wm. Armstrong, confirmed by these fissures and flaws; and there is no other way of accounting for them, except that the gun is subject to a pressure beyond that which it will bear. Other guns in the Table are cast-iron; and I have put them at a little below what is supposed to be the safe tension to which they can be exposed. They burst at 300 and 200 rounds, and in the shunt-gun, at four rounds; so that we are not far wrong. These figures are not meant as showing the absolute tension, but in order to put before your minds graphically, what is better done by figures than can be done by words. Captain Heath said it was impossible that the plan proposed could be carried out. Captain Blakely has explained the manner in which he has arrived at it. I alluded to gun-cotton, which, in proportion as it is pressed, gives a higher degree of elasticity, and there can be no difficulty in filling a portion of a cartridge with gun cotton, that will yield a pressure, on ignition, equal to 2 tons to the square inch, a second portion yielding 4 tons, a third yielding 8 tons, and a fourth yielding 12 tons or more. The first section is near the shot, and is first ignited, to give it motion slowly, in order not to injure the gun by undue tension. Then the greater pressure from the other sections follows the shot up, and gives it a rapidity of translation that no other transmissive arrangement of the power could do. The gun will be subject to a minimum tension, and yet a maximum result will be obtained. The adoption of this principle would admit of the use of guns of a far inferior quality of material, and if of good material of larger size. The recoil would be less with equal weight, and would permit the use of guns of a larger calibre on board ship. I need not trouble you further, except to allude to the initial velocities quoted by Captain Heath, in respect of which he gave only half the facts. You were told in contradistinction to the initial velocities that I gave, that the shunt-gun gave 1,600 feet, I think, comparing that with the velocity obtained from the old 68-pounder, that has not been improved since the dark ages; not venturing to compare it with anything else, with the new smooth-bore, for instance—for Sir William Armstrong has come round to the smooth-bore, and some papers give him credit as though it was his invention. I contend, that it and the new competitive guns are the *United Service guns*; and I protest against Sir Wm. Armstrong taking credit, or being credited for them, by the Ordnance Select Committee. They should go into competition as the United Service guns. I am drawn, however, from my subject, which was about the shunt-guns, that Captain Heath told you gave certain initial velocities, but did not tell you the further fact, that these guns *burst*. What would be said if I produced such a fact? The 150-pounder that I have already mentioned, gave 2,100 feet initial velocity, but then it burst. It and they were very much like the Frenchman's horse, just as he was getting used to live without eating, he died. Such is the character of a great number of the facts which are brought to bolster up an erroneous system. The segment-shell, now that all else is given up, is put forth as the great and important invention of Sir Wm. Armstrong; yet that is not his invention. Here is the patent:—"My third improvement consists in making a shel

"or grenade, having a cavity in the centre for the powder, and between the cavity "and external case, a number of pieces of metal closely packed in one or more layers, "in such a manner that when the shell bursts by the explosion of the powder, those "pieces shall become independent missiles." But the specification is Mr. Holland's, of 1854. Yet it is claimed by Sir William; I contend, that Mr. Whitworth, or any other person having a gun in competition, ought to have had the advantage of this as belonging to the public, for whom it should have been purchased from Mr. Holland, and who ought to have had the credit of his own invention. Lieutenant Reeves, R.A., however, has invented a case-shell, which far exceeds the segment-shell in value.

My object has *not been* to advocate any particular gun, but to deal with principles, with a view to the future, and I have introduced guns or systems, only so far as they were necessary to that end, which was the less necessary, as I had done so in 1862.

The CHAIRMAN: Before we separate, I am sure you will join with me in expressing your thanks to Captain Fishbourne, for the important paper which he has been good enough to read; and I think we may also add our thanks to those gentlemen who have joined in the important and interesting discussion to which that paper has given rise.

LECTURE.

Friday, February 5th, 1864.

Colonel J. P. YORKE, F.R.S., in the Chair.

BALLOON RECONNAISSANCE.

By CAPTAIN FREDERICK F. E. BEAUMONT, R.E.

MR. CHAIRMAN, LADIES AND GENTLEMEN,—I have been asked to give a lecture on military reconnaissance by the aid of balloons, and I have agreed to do so, not, I can assure you, from a belief that I can do justice to the subject, but rather because I have taken a considerable interest in it, and I am unwilling that any effort on my part, however humble, should be wanting which might contribute to the advancement of practical science. Furthermore, if it serves no other purpose, this lecture may give a certain amount of publicity to the subject, and it is a fact becoming daily more apparent, that most new things are aided by publicity, and finally started under pressure from without.

The conservative element is so strong in this country, and we are so much averse to change, that generally it requires to be shown, not only that a thing is good, but that there is a positive evil, in some shape or other, in standing still, before we can make up our minds to change; and I have, too, heard it remarked, that under the pressure which resistance to innovation produces, we change, when we do begin, rather too quickly, gulping down reforms as we would take a dose of physic, instead of spreading them over such a time as would insure our getting the collective wisdom of many brains.

However that may be, making war by means of balloons certainly does not look like standing still; and even in this age of novelties it is somewhat startling to be told, that armies cannot be considered to be properly equipped unless they have with them the means of taking an occasional fly; and that the time has come when the only element of the four remaining unused is about to be made one of the slaves of war. Earth holds us while we fight our battles, fire drives our ships and propels our cannon-balls, water bears our navies, and now air is to give us the power, as it were, of omnipresence.

I shall not weary you by recapitulating what I have no doubt most of you already know—the early history of balloons; nor shall I follow the first inventors through their difficulties with hollow spheres, that were to rise through the abstraction of the air from their interiors, which idea was superseded by the Montgolfière, or heated air balloon, which again was improved upon by the substitution of gas for air. I may point out, however, that the theory of a balloon was correctly struck by the idea of an empty sphere, which would have a tendency to rise in the air with a force exactly equal to the weight of the air abstracted.

The pressure of the atmosphere on the outside of an exhausted receiver which is fatal to this plan, is got over by the substitution for the vacuum of a gas whose elasticity is equal to that of the air outside, but whose specific gravity is less—illuminating gas, or rather, which is generally used, a particular gas specially prepared so as to be light, and hydrogen, are the only gases used.

I should here do justice to our ancestors, and state that there is nothing new in the application of balloons to the purposes of a military reconnaissance; indeed it is one of the first uses that suggested itself (as it naturally would do) to the originators of balloons.

The following extracts from a paper written by Lieutenant Grover, R.E., show where they have been employed. Lieutenant Grover says:—

"The French, by whom the actual idea of balloons was originally "conceived and carried into effect, were also the first to discover the "adaptability of their invention to practical purposes. At the com-"mencement of the Revolutionary War, about ten years after the pro-"duction of the Montgolfier balloons, an Aërostatic Institute was "formed by command of the French Directory (at the suggestion of "Guyton de Morveau) in the Ecole Polytechnique, and under its "superintendence reconnoitring war balloons were constructed by a "M. Couté, and supplied to each republican army in the field. The "army of the Rhine and Moselle was provided with two, viz., the "'Hercule' and 'Intrépide'; another named the 'Céleste' was pre-"pared for the use of the army of the Sambre and Meuse, the 'Entre-"prenant' for the army of the North, and a fifth was destined for the "army of Italy. That attached to the army of the Sambre and "Meuse, under General Jourdan, was first used May, 1794, by Colonel "Coutelle, at Maubeuge, before Mayence, in reconnoitring the enemy's "works. This balloon, which was twenty-seven feet in diameter, and "took at first fifty hours to inflate, was retained to the earth by two "ropes, and the aëronauts communicated their observations by throw-"ing out weighted letters to the General beneath. After this method "of reconnoitring had been successfully practised four or five days, a "17-pounder gun was brought down to a neighbouring ravine, and "(being thus masked) suddenly opened fire upon the balloon. Several "shots were fired without effect, and the machine was then hauled "down; but the next day the gun was forced to retire, and the "reconnaissances were then carried on as before. After two or three "weeks the balloon was moved to Charleroi, distant from Maubeuge

" about thirty-six miles. To save the expense and trouble of another " inflation, it accompanied the troops at a sufficient height to allow the " cavalry and baggage waggons to pass beneath, ten men marching " on either side of the road, and each man holding a separate rope " attached to the balloon, which was thus retained at its proper eleva- " tion. After making one observation on the way, the balloon arrived " before Charleroi at sunset, and the captain had time before close of " day to reconnoitre the place with a general officer. Next day they " made a second observation in the plain of Tumet; and at the battle " of Fleurus, which took place on the following day, June 17th, 1794, " the balloon was employed for about eight hours, hovering in rear of " the army at an altitude of 1,300 feet.

" The Austrians after some time discovered it, and a battery was " opened against the aëronauts, but they soon gained an elevation out " of the range of the enemy's fire, and the information concerning the " Austrians' movements (which they were enabled in this manner to " supply to General Jourdan) contributed mainly, it is said, to the " success of the day,* the result of which was the loss to the Prince " of Coburg and the allied armies of all Flanders, Brabant, &c."

" The next battle that the French gained through the assistance of " a balloon was near Liège, on the Ourte river. As the Austrian " officers afterwards said, 'One would have supposed the French " general's eyes were in our camp,' for they were attacked at the " critical moment of sending off their guns and baggage by the rear, " the French (though occupying much lower ground than the Austrians) " having been intimately acquainted with all their movements by " means of their balloon. The result of this battle was of very con- " siderable importance to the French, as it gave them all the country " between Liège and the Rhine.

" They afterwards used reconnoitring balloons at the sieges of Mentz " and Ehrenbreitstein, 1799. A balloon was also attached to the army " sent on the memorable expedition to Egypt. What service it ren- " dered there we are not informed; but after the capitulation of Cairo " it was brought back with the remains of the army to France, and " was afterwards used by MM. Biot and Gay Lussac in their celebrated " ascent for philosophical investigations."

The French again made use of balloons in their Italian campaign of 1859, a reconnaisance having been made by the brothers Goddard before the battle of Solferino on the 23d of June; and the latest employment of these engines of war is that by the Federals in the present American war. As I had an opportunity of inspecting their

* A Dr. Miers, of Hamburgh, in his journal that he published on his excursion to Paris tells us that :—" J'ai vu à Paris et à Meudon le Capitaine Coutelle, le même qui le 17 Juin, 1794, montoit le ballon qui dirigeoit la merveilleuse et importante reconnoisance de l'armée ennemie à la bataille de Fleurus, accompagné d'un Adjutant-Général. Je lui ai parlé de son voyage aérien, pendant cette bataille, si decisive par suites dont le succès est du en partie à cette expedition aerostatique d'après le jugement unanime des personnes impartial. Coutelle correspondit avec le Général Jourdan, Commandant de l'armée Francaise, par les signaux de pavillon convenus." —*From Major-General Money's Pamphlet.*

apparatus, and made one or two ascents before Richmond, I shall speak further of their arrangements.

I have now done with the past, and shall take the art as it stands at the present time. I shall commence by pointing out to you the nature of a balloon reconnaissance, and showing what is and is not expected to be gained thereby; and shall conclude by explaining the practical details of the apparatus necessary to a complete balloon equipment.

Everybody who has been with an army in the field must have noticed the anxiety with which reports from the front are looked for, and the care taken both by the quartermaster-general's and engineers' department to obtain information; and those who are strangers to active war must have remarked how often the word reconnaissance appears in newspaper reports of operations. Now a reconnaissance simply means an attempt to gain information of the whereabouts of an enemy, and as all dispositions should be made, if possible, with a certainty as to his position, it follows that the results of a reconnaissance are often of invaluable consequence to a general; and even when nothing has been discovered, a sense of safety in the knowledge of the absence of danger is produced, which can hardly be called only a negative advantage.

Those people, whose duty it is to survey or explore a country in the vicinity of an army, do so by penetrating in various directions so far as they dare go, by following out the rivers, streams, and roads, and, above everything, by taking all opportunities of extending their vision. An intelligent officer climbs the highest tree, ascends every rising ground, and gets to the top of any house that may offer him a chance of seeing more than he could do from the ground; in fact, he has never seen far enough; but with all his energy, it frequently happens, or to speak more correctly, it almost always happens, that his sight is bounded by woods, hills, or other obstructions, and this is chiefly the case in a closely wooded country, where he would most wish it otherwise. The highest tree is but a few feet above its neighbours; a house, if there, offers little better opportunity; while church steeples or monuments are seldom met with. The advantage of a hill overlooking a plain is lost with a change of position, and to see over a rising ground, however slight the rise may, is absolutely impossible. Considering the above, I think it will be concluded that if a reconnoitring officer could find a pillar like the Monument erected, say every mile of his route, it would much facilitate his operations. By one sight from such an elevation, he would be able to trace the course of the rivers, and roads, running beneath him; and he would be able, without traversing, to lay them down in some sort of way; he would, furthermore, be able to recognise the correctness of a map, should one be in his possession. Within his range of vision, the officer would be able to have certainly a much better idea than he could have from the ground, of the disposition of an enemy's forces; or if it so happened, to establish the fact of the ground being unoccupied.

Now, the balloon is proposed to supply this desideratum and nothing more. It is intended by its means to have a monument permanently

with an army, but with this difference, that in place of being established only every mile, it can be set up at will; and in place of being only some 200 or 300 feet high it can be 1,000, and its range even further extended. It is true that as at present arranged it cannot be said to be always available, but of that I will speak again. I cannot myself see how it can be doubted that in some, if not in many instances, to obtain an extended point of observation must be a great advantage. The information brought from the balloon may often be negative, that is, the report will simply affirm that no enemy is in sight, or that no change has taken place since the last ascent; still the time will come when the intelligence will be invaluable, as containing new or affirming doubtful facts, and at the worst the balloon can only be set down as a not very expensive incumbrance, when it should be remembered that its expense is, comparatively speaking, insignificant, the full cost of a suitable apparatus being roughly some £500 or £600; and as regards its being an incumbrance, it can be conveyed with as little inconvenience as three baggage waggons.

Many people have asked me rather sarcastically how I proposed to win battles by balloons. They had evidently borrowed their ideas of balloons from Tennyson's somewhat vague prophecy, where he says:

> For I dipt into the future, far as human eye could see,
> Saw the vision of the world, and all the wonder that would be;
> Saw the heavens fill with commerce, argosies of magic sails,
> Pilots of the purple twilight, dropping down with costly bales;
> Heard the heavens fill with shouting, and there rain'd a ghastly dew,
> From the nation's airy navies grappling in the central blue.

and fancied that iron-plated balloons and Greek fire poured upon the people below were not altogether beyond my notions.

Now, it will have been seen that the balloon is to take no active part in the fighting; in fact, when within range of the enemy's guns it should be moved (though I may here remark that owing to its position and uncertain distance, a balloon is an extremely difficult thing to hit, and when struck, except by a shell or on the car, little damage would be done that could not be easily repaired); and that, in fact, the balloon is supposed to be of no assistance to the general whatever, beyond placing him *au fait*, or as the Yankees call it, "posting him up to the latest date".

I will now give you the results of such reconnaissances as I have seen made, and make some remarks on the way in which they were carried out.

The theory of ballooning is so simple, and the practice of it so difficult, that opinions as to its success must be based upon the result of actual experiment rather than foregone conclusions.

The first time that I saw the American balloon used was in the spring of 1862. I joined M'Clellan's army at Cumberland, landing on the Pamunkey river, one march below the celebrated White House, and I accompanied their advance to Gains Mill, on the edge of the valley of the Chickahominy.

I may here mention that I came among the Americans a perfect

stranger, with no introduction of any sort or kind, but that after I had got clear of the Washington officials, by whom my journey had well nigh been frustrated, I was shown every possible attention, received at the head-quarters of the army with hospitality, and given every facility for going and seeing where and what I would.

It was at Gains Mill that I first saw the balloon. It was then with the advance guard of the army, under General Stoneman, the main body being some two days' march behind, and so far as I could learn no difficulty had been experienced in causing the balloon to accompany the advance, which, indeed, is its proper place. It can be allowed in still weather to rise some 20 or 30 feet, so as to clear obstacles, and the men holding the guy lines, march regularly along. If the wind be at all high, it is necessary to discharge the gas.

The staff and apparatus were as follows :—one chief aëronaut, professor, and a civilian, but who was given, I think, military rank; one captain's assistant, and 50 non-commissioned officers and men. There were then present with the army two balloons, and two generators. Whenever the weather was sufficiently calm, the balloon was up hovering over the camp at altitudes varying from 500 to 1,000 feet, and reports were sent in daily, or oftener if need be, of the observations taken, noticing any change that might have taken place in the disposition of the troops, or appearance of any works visible. Evening and morning were found to be the times generally best suited for observation, as the air was clearer and the shadows were larger.

The balloons were made of the best silk, very strongly sewn, and were inflated with hydrogen produced from two generators, which were simply large wooden boxes, lined with some material not acted on by sulphuric acid, and mounted on wheels, each being capable of being drawn by four horses. The gas was generated by the action of sulphuric acid and water on iron, and was passed through two lime purifiers before being delivered cool into the neck of the balloon. The balloons kept their gas for a fortnight, that is, having been filled up, they still retained, after that time, sufficient ascentional power to be of use.

The guy lines were three in number, one thicker than the other two, the intention being that one should take the main strain, the others acting simply as guys.

The method of manipulation was carried out as follows: the main rope was passed through a snatch block firmly attached to the ground, and each of the three having been manned by some ten men, the machine was allowed to rise. Communication was maintained when the altitude was small, by shouting, and at 1,000 feet, messages were written on a bit of paper, and dropped with a stone to the ground. Telegraphic communication was also established. Indeed, at the battles that resulted in M'Clellan's being driven back from Richmond, the instrument in the car of the balloon was in communication with the line wires leading to Washington, so that the President sitting in his closet might literally receive earlier intelligence than the general in the field, of the turn the battle was taking; this, however, was a vicious refinement, for it is needless for me to point out, that the only

information the government should receive, ought to come direct from the general in command.

It may be well here to explain the position of the army at the time I actually saw the balloon used.

M'Clellan, who was in command of the army of the Potomac, especially destined for the capture of Richmond, had landed with his forces at Fortress Monroe, an ordinary bastioned work on the extremity of the Peninsula, formed by the York and James rivers; he had advanced against the lines of Yorktown, which stretched from river to river some 30 miles above Fortress Monroe. The Confederates abandoned their position so soon as M'Clellan's arrangements for shelling it had been completed. I do not think, however, they had any further intention than that of delaying his advance as long as possible. Past Yorktown, he advanced, with his right resting on the York and Pamunkey rivers, until he reached the White House situated on the latter, at the point where it is crossed by the West Point and Richmond Railway. Here he left his water base of operations, and was obliged, for his supplies, to trust to land carriage. From the White House to Richmond is some 50 miles, and Gains Mill, which is on the bank of the,—so to speak,—Chickahominy valley, is about 10 miles from Richmond. The army, 100,000 strong, took up, in the first instance, a position entirely along the banks of the Chickahominy, some six miles on either side of Gains Mill. The left was then thrown forward across the stream, and this was the last onward movement made, as the Confederates succeeded in repulsing the advance, and at the same time attacking the White House position, cut off M'Clellan from his base of operations, and obliged him to beat a hasty and disorderly retreat to the cover of his gunboats on the James river.

Nature, in that part of Virginia, is prolific in vegetation. A great part of the land is still covered with trees, and as the ground is undulating, it was very unfavourable for making a reconnaissance. At Yorktown many ascents were made, but I did not hear that they had been attended with any advantage beyond the indirect one of looking into the enemy's works. No sorties of any importance were attempted, hence there was no particular gathering of men to be noticed, and the prolongations of the faces of the batteries, necessary to establishing correctly the position of the counter-batteries, were known by observation from the ground, so that on the whole there was little scope for the balloon; in such a position, however, plenty of circumstances *might* arise which would prove its value.

At Gains Mill I made one or two ascents, and had there an opportunity of judging practically of the advantages to be derived from a balloon reconnaissance. From the top of the hill whence the balloon was raised, my vision was bounded all round by trees, so that I could in no direction see further than half a mile. As we rose, it was curious and beautiful to watch the gradual extension of the horizon; first, the country appeared all wood, from the eyes enfilading, as it were, the tops of the trees; next open spaces began to shew themselves nearly beneath the car, and then, as the altitude increased, they could be seen further out.

Looking more closely, I could distinguish roads here and there crossing the open, and where the direction was favourable I could trace them through the woods.

The Chickahominy, like a silver thread, half hid in the line of trees that shaded its banks, lay beneath me, all signs of its forming the centre of a valley being lost, as from the car of a balloon one cannot trace the difference between hill and plain, owing to there being nothing to guide the eye.

After getting, as it were, my air legs, and becoming accustomed to the situation, my first anxiety was to see the Confederate soldiers, and my next to look at Richmond. So far as the enemies' army was concerned, I could only see their pickets thrown forward to the banks of the Chickahominy, with their supports on the heights behind them; no army was near them, unless it was concealed in the woods, whose tree tops only I could see. These woods were certainly big enough to have contained 50,000 men, provided they remained still, and did not light any fires, both somewhat unlikely provisions.

But Richmond, the looked-for goal, the capital of rebellion, lay clear enough away to the westward, with the sun glancing on the roofs, and the church steeples showing up above their neighbouring buildings; the city, could be distinctly made out. To get that place that then lay so temptingly beneath me, more blood was to be shed than possibly any other struggle in modern war had cost; and yet at that time the Federals were confident enough, and the expectation of soon being able to judge for themselves, gave a double interest to the inquiries as to what Richmond looked like. I could see the three camps of the Confederates round the place, one of them at Manchester, on the James River, but the distance (some 10 miles) was too great for me to distinguish more than the bare fact of there being three camps, and make the very roughest possible guess at their size. I could make out earthworks, thrown up apparently to bar the main approaches to Richmond, but of their character or strength I could judge little. Had the army got so near Richmond that the balloon could have ascended within three miles, a report of the nature of the defences could no doubt have been made, which would have cost a reconnaissance supported by a strong force to have obtained it in any other manner. I was present when the firing of a battery of artillery was directed from the balloon; the circumstances were as follows:—A picket of the enemy had established themselves among the trees on the banks of the Chickahominy, in a position near to the spot selected for a pontoon bridge; it became of importance to dislodge them, as it was fancied that they were strengthening their position, but owing to its being hid by some low banks, the battery that it was thought they were making, was invisible. The balloon being up and the signals preconcerted, the battery opened fire, the people from the car telling the artillerists which way their shot were dropping. The result of the operation was that the Confederates were driven from their cover; but I cannot say in that instance that I was impressed with the advantage of artillery fire directed from the air, though there are cases, no doubt, where a balloon might be similarly

and profitably employed. For instance it is not at all an uncommon artillery problem to breach an unseen revetment, when an occasional peep to see how the work was getting on, would be most welcome.

In this country some experiments on the subject of balloon reconnaisances have recently been carried out, and will, I believe, be continued next year. Up to the present time two ascents have been made, with a view of determining as a preliminary measure, first, the value of an elevated point of observation; and, secondly, whether the car of a balloon is capable of affording such a point. Simply with reference to the above, an ordinary balloon would do, provided a sufficiently still day were chosen; arrangements were therefore entered into with Mr. Coxwell for the use of his balloon, the Government finding the gas and necessary ropes.

The disposition of guy lines was the same as that which I have described as used by the Americans.

The first ascent was from Aldershott, on the day of the Royal review, which happened to be an exceptionably still one, with hardly a breath of air. Under these favourable circumstances an altitude of 1,200 feet was obtained, and the balloon was manipulated with ease; it took some quarter of an hour to haul the balloon down from its full height, and considerably less to raise it. Practice will, however, suggest both quicker and safer methods of managing this than that then used.

From 1,000 feet high the country lay mapped out beneath me for miles, though the haze prevented a very distant view. All notion of the relative height of ground was lost, indeed it was difficult to recognise as elevations the Hog's Back or Cæsar's Camp, on which latter place the troops were being reviewed. At that distance, then some three or four miles, the movement of the troops could be seen, and the tunes played by their bands distinctly heard, though from the ground neither the one or the other could be done.

During an ascent from the Arsenal, at Woolwich, the troops were sent out in different directions, so that if possible their positions might be made out from the balloon. This was not done, though I and my companion, Lieutenant Grover, examined the ground for an hour and a-half; it should be remembered, however, that the number of men in each division was small, and though we could not say where they were, we told where they were not, and the quantity of ground thus declared to be unoccupied was considerably more than could be seen from the top of any ordinary terrestial point of observation. Afterwards when we were about a mile high, having gone away free, and somewhere over the new docks at Blackwall, we clearly made out the troops assembled on Woolwich Common, preparatory to being dismissed to their barracks. The result of these two experiments appeared to me to show that the manipulation of balloons in the absence of wind was simple; that an altitude of 1,000 feet or less gave a sufficiently extended range of vision, and that to those who were accustomed to it, there was nothing in the car of a balloon that made it unsuitable as a point of observation.

I must however confess that reconnoitring from a balloon is not a pleasant occupation, in fact it is as unpleasant as the free ascent is

delightful, the least wind causes the huge machine to oscillate, and the motion, both in ascending and descending, given to the car by the unequal action of the ropes is disagreeable; the danger, too, is much more in a partial than in a free ascent, and much caution is necessary; the ropes cannot be made over strong, or they would be too weighty, and in the event of their breaking, the balloon, relieved suddenly of so great a weight, would shoot up like a sky-rocket, though a judicious use of the valve would no doubt prevent serious consequences. I have now done with the practice of reconnoitring by means of balloons, and shall make a few remarks on the apparatus necessary to effect that practice successfully.

To be applicable to military purposes, a balloon must possess the following qualifications:—1st. It should be readily available after the order for an ascent had been given, and it should be capable of being used in any place.

2nd. It should be capable of being used in any wind less than 15 miles an hour.

3rd. The height capable of attainment must be 1000 feet.

4th. The apparatus must be able to take up two people at least, with ballast and the necessary observing apparatus.

5th. The balloon must be so made that it can retain its gas for a reasonable time, viz., a fortnight, that is, that at the end of that time, its ascentional power must be such, that it be still capable of being used with a reduced weight.

On considering the above requirements, it appears to me that the Montgolfier, or heated air balloon, is at once excluded on account of its necessarily large size, which would make it unmanageable in any but the quietest weather; furthermore, the practical details of the heating apparatus, and danger attending its use, would be great, though perhaps not insuperable.

Gas remains therefore, and the choice lies between coal-gas and hydrogen, the advantages of the latter are its less specific gravity, which for present purposes is of great importance, as with a given lifting power, it presents a proportionably less area to be acted on by the wind, and the materials necessary for its production are more easily available, coal being a bulky article to transport, and otherwise not found usually with an army, while iron always exists in every camp, and the proportion of acid necessary to produce hydrogen gas from it is not very large.

Now a sphere with a diameter of 30′ has a cubical capacity of 14,000 feet.

1,000 cubic feet of air weighs 77 lbs., and, assuming the specific gravity of such hydrogen as would most likely be used at ·1, 1,000 cubic feet of hydrogen would weigh 7·7 lbs., and 1,000 cubic feet of coal-gas at ·3 = 23·1. We have thus

14,000 feet of air weighing	1,078 lbs.
14,000 feet of hydrogen weighing	108 lbs.
14,000 feet of coal-gas weighing	324 lbs.

which gives with hydrogen an ascertained power of 970 lbs., and with coal-gas 754 lbs.

somewhat like a ship in a stream-way. The advantage would be gained, however, at the expense of weight, as the sphere is the form of greatest capacity for a given surface; and further, of convenience, as there are considerable practical difficulties in the way of employing any but a globular shape, owing to the unequal strain on the netting, to which an elongated form would be subject. A more likely scheme to answer, though, perhaps at first sight somewhat wild, is to combine the principle of the kite with that of the balloon, and so make the untoward force of the wind correct itself.

Ballooning is yet quite in its infancy, and the first apparatus got up for military purposes would, doubtless, receive many alterations, which practice alone could suggest. Still, in my opinion, it is even as the art at present stands, capable of useful application, and if it failed to answer all expectations, the failure would not be great, nor the experiment costly.

In conclusion, though I fear I have already overstepped my time, I beg to offer a few remarks on the subject of aerial locomotion, which has always some interest, but which lately has attracted especial attention; Nadar having brought over a big balloon, for the avowed purpose of collecting funds, with which to carry out his theories of air travelling, which, so far as I understand them from his writings, are remarkably visionary.

Supposing a hook to be put in the sky, and a balloon anchored to it, the wind would press on that balloon with a force depending on its velocity, and the area of the balloon.

Now, it is found that the pressure of the air on the surface of one square foot is equal to ·005 lbs., and the pressure increases as the square of the velocity, because in a given time, with double the rate of motion, not only twice the number of particles strike, but they strike with twice the force, hence, at 15 miles per hour, the pressure would be 1·107 lbs.

Assuming the case of a balloon 30′ in diameter, which is the size of the one I have spoken of previously, the area will be 675 feet; hence, neglecting the difference which would be caused on the one side by the spherical shape of the balloon, and on the other by the resistance of its cordage, car, &c., the total pressure exerted by a wind, moving at a velocity of 15 miles per hour, would be 742·5 lbs. Now the effect is the same so far as the balloon is concerned; whether it be stationary and the wind moving, or the air stationary and the balloon moving, which latter is the case in point.

To impart, therefore, to the balloon, a motion of 15 miles per hour, would require a continual pressure of 742·5 lbs.; now, with the very lightest possible description of machinery, and with that machinery made in the lightest manner, it might be possible to construct an engine, which would give a duty equivalent to 742·5 lbs. pressure, and yet be within the weight which the balloon could lift, viz., 970 lbs.

At first sight, one is apt to jump at conclusions, and fancy that the thing is done, but the greatest difficulty is yet to come; the engine may be ready to give the power, but it is useless unless it has some fulcrum against which to act, and the loss of power is so great in

obtaining a fulcrum from the air alone, as practically to render available only a very small proportion of the power at command, the remainder is consumed in giving the necessary velocity to the screw, or other machinery used.

This will be readily understood, if we think over the following considerations: a corkscrew, working into a cork, at each revolution advances the distance between two threads; the screw of a steam-vessel does not, but for every ten turns advances, say only nine times the difference between the two threads, or what is the same thing, nine times the pitch of the screw, this difference being called the slip. Now this is owing to the mobility of the particles of water, which themselves are driven back, and the slip would increase with the facility of these particles for motion, or, in other words with the mobility of the fluid, air being infinitely more subtle than water, the slip, in place of being $\frac{1}{10}$th would be $\frac{9}{10}$ths (I am not, of course, now using figures, other than as illustrations, they are not correct), hence, of the force which was at command, 742 lbs., only 76 lbs. would be available to drive the balloon, which would correspond to a velocity of $1\frac{1}{2}$ miles per hour. The remainder, 666 lbs., being wasted in keeping the necessary machinery in motion.

That this reasoning is correct, that little toy very clearly shows, which is usually brought forward by enthusiastic aeronauts in support of their theories, I mean the flying top, which consists of light vanes fixed on a shaft, to which is given a rapid rotatory motion by means of a string. While the rotatory motion is sufficiently rapid, the top continues to rise; the vanes may not be very mathematically set, but I doubt whether any theoretical setting would alter the effect, and it will be seen that it takes a very strong pull, amounting to some pounds, to enable the machine to rise, though itself perhaps weighing an ounce or two, thus showing the amount of power wasted, so to speak, in obtaining a fulcrum.

Now, I deduce from this, that all theorists who hope to attain aerial locomotion by any combinations of steam-engines, or by altering the known appliances of vanes, screws, &c., come under the class of people who do not understand their subject. The real points to be obtained, to enable aerial locomotion to become a *fait accompli* are two, either, and principally, a new motive power must be discovered which shall combine a greater power with a less weight, or some means must be found of obtaining from the air a fulcrum as available as that furnished by water.

It will be seen, however, that even with the assumption I have made, I have got a speed of $1\frac{1}{2}$ miles per hour, which may be said to be something, and, I think, that very possibly even 10 or perhaps 12 miles per hour, might be got; but were that speed gained, beyond its curiosity and the credit attaching to the first step in a new science, nothing practical would have been obtained; for in the stillest day there are currents of air moving from 10 to 15 miles per hour, against which the balloon could barely hold its own, and from 20 to 25 miles I suspect to be the more ordinary rate of the air, some half mile from the surface of the earth.

If, however, even in such a wind, a rate of motion of 10 miles per hour could be given, it would render balloon journeys less hazardous, as at the end of one hour's travelling the aeronaut would have the power of changing his position within 10 miles on either side of a given spot.

Under existing circumstances all plans of doing without a balloon, and imitating the top, may be put on one side at once as visionary; from what I have shown above, a weight of 970lbs., gives an effective pressure to counterbalance it of only 76lbs.; hence the machine must fall. Toys have been made with springs which support themselves until the springs are run down, which toys lead people at first sight to think the thing is practical. They forget, however, that the little spring when wound up represents the whole force, which has been put into it extraneously, and in reality has nothing whatever to do with the real question, unless the power which wound up the springs were supported by the machine itself. If, even it were possible, the fearful danger, of making the safety of the apparatus, depend on the continuous action of a complicated piece of machinery, would be such that few but maniacs would make the experiment.

Evening Meeting.

Monday, February 15th, 1864.

Captain E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between 2nd and 15th of February.

LIFE.

Morant, J. L. L., Lieut., Royal Engineers. 9*l.*

ANNUAL.

Prowse, J. F., Lieut. R.N. 1*l.*
Field, G. T., Major, R.A. 1*l.*
Graham, Allan, Captain, Renfrewshire Rifle Volunteers. 1*l.*
Davies, G. S., h.p. Capt. 6th Dra. Gds. 1*l.*
Bridges, W. W. S. Commander R.N. 1*l.*
Hunter, Edwd., Captain, 62nd Regt. 1*l.*
Laws, M. R. S., Ensign, 62nd Regt. 1*l.*
Marryat, J. H. Captain, R.N. 1*l.*
McNair, Fredk., Capt., R.A. Madras. 1*l.*
Napier, R. H. Lieut., R.N. 1*l.*

THE APPLICATION OF STEAM POWER TO THE WORKING OF HEAVY GUNS.

By H. D. Cunningham, Esq., R.N.

The question, "Can we continue to work our heavy guns by manual power?" is one which cannot fail to engage the serious attention of artillerists, and is the one which has brought me before you this evening. It is a subject, too, which in this practical age may possess a certain amount of interest to every one. My question is of course raised by the growing size and weight of ordnance. Already we have reached a gun of twelve tons in weight, and in Mr. Reed's new ship, the Bellerophon, we are promised that a part of her armament shall consist of 600-pounders, which must far exceed the 12-ton gun in weight and proportions. And shall we stop here? There is full reason to believe we shall not. When we have our 600-pounders we

shall then look forward to the 800-pounders, and so on to 1000-pounders. And heaven only knows where we shall then stop. And then will indeed apply my question, if it be not already applicable to guns already in use, "Can we continue to work our heavy guns by manual labour?" Now this doubt has not been raised in my own mind alone. It is one that has come to me in various shapes from many intelligent and far-thinking officers, and is generally accompanied with the admission, with reference to the subject of my paper, viz., the application of steam-power to assist in the working of heavy guns, "We must come to something of the kind at last."

The question is not, as it were, a gunnery one; that is, it does not refer to the science of gunnery; for if it had done so, I would not have presumed to go into it, not being a practical artilleryman. No; it is purely a mechanical question; and it is as a mechanic that I deal with it.

For some time past I have been under the strongest impression that we were drifting into such a state of things, that more extended power must be applied to the mechanical part of the working of great guns. Watching the rapid growth in the sizes and weight of ordnance during the past two years, it appeared to me to be unreasonable to suppose that ordinary manual power could remain as the prime motor for working them, and that the arms of flesh and bone must give way to the iron arms and sinews of the mighty steam-engine. I own, my views have often been shaken and discouraged by remarks of experienced gunnery officers, that come what change there may, in the weight of guns, they must be worked on board ship by seamen; that the number of men must exist in the crew of a fighting-ship, and what may be required in power can be obtained in numbers of men. But looking back on the experience of the past thirty years, and viewing the stubborn fact how much animal power has yielded, right and left, to steam power, then I believe that many here will agree with me, that measuring such opinions by the past, they can scarcely be held to be tenable.

I will admit personally to a large amount of conservative feeling on this subject, dear as it must be to every Englishman, and would that we had remained in that good old state of things, when the weight of our ordnance was such that the success of an action depended on the thews and sinews of our gallant seamen; when a frigate with 56 cwt. 32's on her main deck was considered to be a heavy ship; when we had no costly steam navy to draw the string of taxation so tightly round our throats in the shape of income-tax; no iron-clad monsters to mar the seaman's pleasure in the contemplation of his ship, which in good old times gone by, was poetically described as his ideal of beauty, next or even before his mistress. But those days are gone for ever; that iron monster of revolution, the steam-engine, has changed all these things. If it had not been for his mighty power we should have had no iron-clad ships; without iron-clad ships we should have had no mammoth guns. But the crustaceous sea-monster once created, suggested a new field for the exercise of mechanical and gunnery science. These ironsides which were at first vauntingly pointed out as

defying the effect of shot and shell, and within whose casemates the crew were to fight unharmed, unhurt, must be pierced. An impulse was thus given to gunnery science; the talent of our engineers, and the resources of our iron establishments, were roused to the work. Gun after gun, shot after shot, have, since the creation of the iron-clad ships, been rapidly progressing upwards, in size, weight, and tremendous effect, until, as before remarked, we have now arrived at guns of 12 tons weight actually in use; and have every prospect in a few months more, of having ships afloat, armed with 600-pounders! But we will now consider some leading features of the subject of the possibility of continuing to work modern guns by manual power, upon the argument that power to any extent may be obtained by numbers of men. Now, every one who is familiar with the operation of working broadside guns on board ships,—for it must be understood, it is with reference to this arrangement of armament, I have hitherto directed my remarks,—that the space about and in the immediate neighbourhood of the gun is very limited, and especially so in the case of guns of the huge size which we are supposed to be now treating of. It will be also readily admitted, that a man to exercise the full power of his strength, must have a certain space allotted to him; he must place his body in a suitable attitude to call into play the full energy of his muscles, and unless he has the space for this purpose, he cannot use the full amount of his strength. Consequently, when men are crowded together, which they necessarily must be, to make up the required amount of manual power for working one of the modern heavy guns, a very large amount of their energy is diminished, and the full amount of power expected to be derived from a given number of men will surely not be arrived at. The amount of hauling power amongst men crowded together will be seriously affected by the motion of the ship. Every seaman knows how much loss of this power there is, when the ship is knocking about at sea, and it is easy to account for it; much of the muscular energy of the man is applied to keeping his balance, and hence he cannot use the same amount of strength as when standing firmly on a steady level. I hold, then, that the principle of making up power by numbers for working heavy guns, is certainly limited in its application. Beyond a certain number of men, the extra number that may be applied will tend to diminish the muscular power of the remainder, and when dealing with the tremendous weights that are promised in the shape of future guns, it will be difficult to make up the required power by number of seamen. On Thursday last I had the pleasure of witnessing the exercise of one of the 300-prs., a 12-ton gun, on board the "Excellent," or rather "Illustrious," and certainly the facility with which the gun was moved about much exceeded my expectation, and went far to negative the impression which I had on the subject, when the introduction of such guns on board ship was only talked of. The number of men at present forming the crew of the gun is twenty-one; and ten men on each side ran the gun out. I did not see the gun run in by manual labour, as it was firing exercise, and so the gun came in by itself, but I was given to understand that it could be dragged in by the same amount of manual

power. The mechanical appliances for running the guns out consist of a treble block and double block, of course on each side. Now, the guns on board the "Illustrious" can certainly be only recognised as battery guns, that is, the deck upon which they work is always on a level. The real practical trial of working such guns has yet to come. The question, how far these ponderous masses can be worked up varying gradients, and subjected to all the forces incidental to heavy guns at sea, has yet to be seen;* and it must be fairly doubted if twenty-one men, or half as many again, will be able to control those ponderous guns at sea. Some time ago, when I was collecting information on the subject, I was informed by officers in the "Resistance," that although the standing crew of the Armstrong 110-pr. was seventeen men, they always had twenty-one to work it at sea. One word more on this point: it has often been remarked to me by officers, that they always dreaded casting loose their 68-prs. at sea, and were always delighted when the guns were again secured. If then this anxiety existed in regard to guns of between 4 or 5 tons in weight, how great it must be, or rather will be, when dealing with guns three times heavier, with probably all the embarrassing accompaniments of wet, slippery decks, a consideration which must be added to those already advanced as regards the impossibility of men putting forth their full strength under certain conditions at sea, and which I cannot help believing, must impress many with the desirableness of applying such a power to work heavy guns, as will not be affected by circumstances of this description.

On Thursday last, as I contemplated the captain of the gun pointing and directing his gun, the impression came forcibly upon me that in that individual was vested the power, and, if I may use the expression, the intelligence, of the gun. The animal power on each side of the gun simply represented power put at his command to move the gun in the direction he required, and to execute the other purely mechanical parts of the working of the gun, but had little if any sympathy in the intelligent part of the operation. Obedient and well-trained as the men were, still the wishes of the master-mind were not carried out with that prompt mechanical action that it appears to me the conditions of modern gunnery require; and I must also add, with that *smoothness* that could be, were mechanical power used instead of animal power. As the command was given,—muzzle left or muzzle right, as the case might be,—the result did not immediately follow on the expressed wish. The men had, as it were, to gather up their strength before they applied it; and even when they did begin to pull, it was some little time (but, mind you, only very little, but still a little loss of time) before they could obtain the necessary harmony of action to apply their strength with the desired effect. I noticed, too, that this spasmodic application of power, if I may use such an expression, sometimes resulted in the slide being dragged beyond the desired

* The mean of the number of rolls per minute of the French iron-clad squadron of seven ships in fine weather, with a long slow swell, has been stated to have been six, and the extent in degrees 11°.—H. D. C.

point, and the reciprocating force on the other side had then to be put into action to drag the slide back. Now, reflecting upon these observations, it appeared to me that they were grave defects in the mode of working guns, and altogether inconsistent with the requirement of modern gunnery. It is more than probable that a considerable portion of future sea-fights or battery engagements (which God forbid, at the same time, that such should ever occur) will be under conditions of one or both of the engaging bodies being in motion, and in rapid motion too. The success, then, of the discharge of a gun, will depend upon the quick and steady manner it can follow a passing object. It will not be as in days gone by, load and fire, load and fire, and hit where or what you can, or nothing at all, so long as you blaze away, —a mode of fight which, ridiculous as it may appear, I believe some of our noblest actions were won by, but it will not be so now *every one of our modern costly bullets must have its mission surely selected for it before it leaves the cannon's mouth.* Then, I maintain, that the efficiency of our present elegant and beautiful arms of precision, for such they must be styled, must be impaired by the palpably defective means for the training of them. I repeat, those 300-pounders on board the "Illustrious" are truly magnificent guns, and proud as a nation we ought to be at having them, and thankful to those talented engineers and all concerned, who have provided us with such fine guns for the protection of our shores, and British honour and commerce over the wide wide world. And, I repeat, when I contemplated this huge cannon obeying, almost with intelligence, the biddings of its master-mind, the captain, belching forth, too, its iron missiles, and when done, standing quietly and peaceably to have its iron stomach replenished with more (I must be pardoned for using the expression) of its satanic food, then there was only one thing which appeared wanting, and that was, that that master-mind, the governing spirit of the gun, should have had more complete mechanical arrangements at his command to bring that magnificent instrument more sensibly under his instant will and control, and which, I believe, can only be provided by the application of steam power.

I believe and hope that Captain Cooper Key will make every allowance, if in my mechanical ardour I am uttering words that may *probably* be in contradiction to his views on the subject. I use the word "*probably*" because, although I have had the pleasure of communicating with him several times lately, I cannot say that I know how far he is disposed to go with me in this matter. I have, however, observed that Captain Cooper Key is a true mechanic at heart, and consequently he must not only sympathize in my views, but must also admit that mechanical operations, whatever they may be, must be executed with greater precision by mechanical power than by animal power.

And now, to return to another consideration of the theory, that the power for working heavy guns can be made up by numbers of men. On board the "Excellent" I saw a piece of 5½-inch armour-plate that had been pierced through and through by a steel shot, that would have carried death and destruction with it on the other side. What, then, is the reflection that is created by this fact? Is it not this most unpleasant

truth, that in spite of all our vast expenditure of money to render ships impervious to shot, bullets and guns are now provided to pierce the thickest armour-plate yet laid upon a ship's side; I am not going into the question of armour-backings and such like, but this much I would say, that if we are to conclude that ships' sides can be penetrated, and that men within their casemates will be liable to be shot down, does it not suggest the question whether it will not be desirable to study in every possible manner to fight the guns of a ship with the fewest possible number of men exposed. And surely this is a sound theory. Is it not the perfection of good generalship to do as much harm as possible to your enemy, with the least possible hurt to yourself? Now I hold that the grouping together of large numbers of men in the neighbourhood of a gun, exposed as they would be not only to the effect of solid shot and its tremendous splinter results, but also to shell entering the port, is a thing to be avoided. Imagine, if we can, the destruction which such missiles would deal amongst a cluster of men, and the helpless condition of the gun when deprived of a large share of its working power, which with heavy guns, would be inevitably felt more sensibly in proportion, than with lighter guns. Imagine, too, the exhausted condition which the remaining men would soon be reduced to, from the extra work imposed upon them. On reviewing the picture, let us imagine what the effect of a shell entering the port would be. I scarcely dare permit myself to hint at anything like a panic occurring amongst British seamen, yet the effect of a modern shell between decks of a ship must be something so terrific, that you might almost excuse the strongest nerves suffering under such a trial. Now the iron men which I propose to substitute for flesh and blood will be insensible to all this. Through shot and shell, through carnage and horrors, through noise and confusion, provided their vital parts are not touched, which is not possible, unmoved they will surely and steadily perform their part of the battle. The provision of a few steady and tried veterans to load and direct the guns on the fighting-deck (it must be understood that I provide sundry mechanical helps to assist in loading) will be all the men that will be exposed. All the other portion of the work, as I shall presently explain to you, will be, or rather can be, performed under cover on the deck below, not only greatly removed from danger, but from also the witnessing of the probable tremendous effects of modern gunnery science. The amount of labour required of the seamen will be very small; the really hard work will be performed by the iron men, who can *feel no fatigue, be the action ever so long.* Then let me put it to you, would not a ship, with such provision for fighting, be immeasurably stronger and capable of enduring a lengthened action, than the ship whose powers of endurance depend on flesh and blood.

As I have before observed, my remarks have been hitherto directed to guns worked on broadsides. I have, however, as you will see by-and-by, arranged for an application of steam-power to the working of guns in revolving turrets or cupolas. Many of you may remember that Captain Coles alluded to this in his lecture last year, and said that he knew I was maturing a plan for applying steam-power to work

guns in his cupolas, which he considered would be an advantage. Now in this I have succeeded even beyond what I anticipated, for not only has the mere moving of the gun in and out been accomplished, but other advantages have been obtained which are very important indeed.

At this stage of my paper, I would call attention to the life-preserving character of my designs for superseding manual power by steam power for fighting ships. I should be untrue to the colours under which I have already fought a mechanical battle for this object, and which I trust, by God's help, has been the means of saving many many lives. If I did not admit this consideration as an important element in my present undertaking, it is undoubtedly one eminently calculated to preserve human life. I have no desire to reduce the crews of our ships of war, although with the extended mechanical power for fighting guns which I provide, we cannot hide our eyes to the fact that my inventions tend that way, and may be highly interesting to political economists for that reason, still the power afforded for working the guns with so few men exposed to danger is a feature in my invention which claims humane consideration, and, let us believe, must be acceptable on that account. Those dark ages are I hope and trust, gone for ever when the extent of a triumph in arms was measured by the length of the "butcher's bill." Christian men and gentlemen now enter into the dread science of war with different feelings, and therefore if war must be, if the arbitrament of the sword must be resorted to, then let us study to diminish as much as we can the sufferings inseparable from it.

But now to description.

It is about two years ago that I first entertained the idea of applying steam power to the movement of heavy guns. At starting, the matter appeared full of difficulties. In the first place, it seemed impossible to obtain the necessary direction of forces without resort to complicated machinery. Again, it appeared very undesirable to introduce any remarkable change in the general arrangements of guns, such as their mounting, &c. Whatever I did, too, it was highly desirable not to reduce the fighting organisation too much to a machine; that at least something should be left for the crew to do. Indeed the consideration of the matter resolved itself into the following points:—

First. That if possible everything in the shape of machinery about the gun-carriage should be avoided.

Secondly. That the means should be such as to come within the comprehension of seamen to handle, without the necessity of having an engineer to every gun.

Thirdly. That the motive means should be of the simplest possible character, and placed so low down in the ship as to be out of the way of shot.

Fourthly. That the form of carriage, &c., should be such as to enable the gun to be worked by ordinary means, should any failure arise in the steam power.

Now I think you will agree with me after I have described my plan to you, that these conditions have been very closely adhered to.

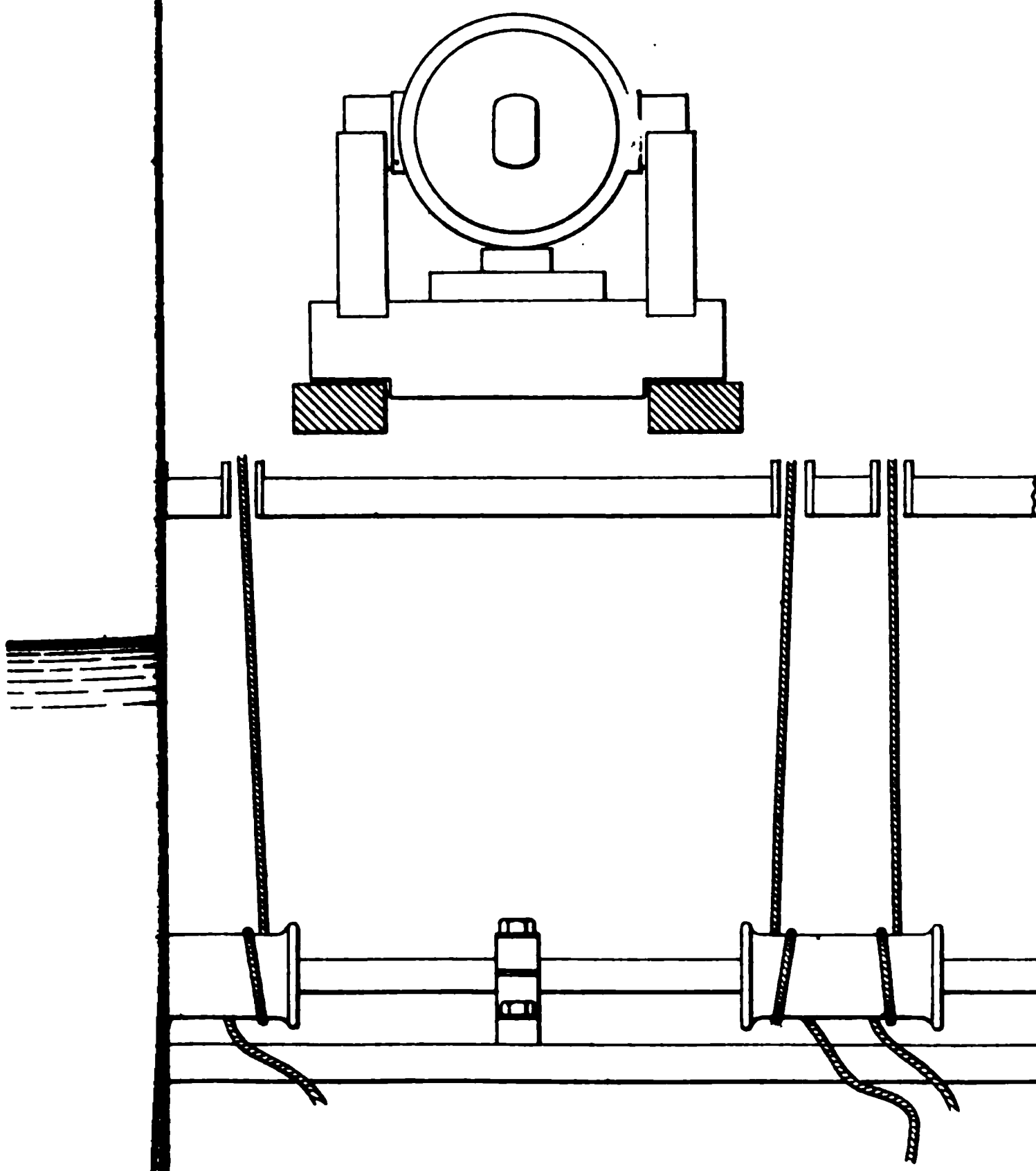
Two forms of applying the steam had to be considered. One with reference to guns worked in broadsides, the other as regards guns worked in turrets or cupolas.

As regards broadside guns, two motions had to be arrived at. One a reciprocating rectilinear motion, for the running in and out of the gun, another a circular horizontal motion for the training of the gun. In regard to the turret, this last motion was provided for, and the running in and out motion alone had to be produced.

Now, I can assure you, when I first took the matter in hand, I was sorely puzzled how I could obtain the different motions for the broadside guns, without entering into cog machinery and other mechanical complications, and thus depart from the condition of simplicity which I believed could alone give practical value to any arrangement of the kind. Various were my plans, and various were my failures, until I conceived the idea of going into the work on the millwright principle of shafting; I determined to lay shafts along the deck, underneath the guns; upon these shafts, have drums or windlasses; lead the various tackles for running the gun in and out and training, down through the deck, to and round these drums or windlasses; and then I had the whole mechanical organisation complete for working guns by steam, and possessed, too, of so much simplicity, as to come within the comprehension and ability of seamen at once to put into operation; we will now refer to the diagrams. Plate VI, Fig. 1 shows, as you will see, a side view of a gun, ship's side and decks. The gun represents a 300-pr., or 12 ton gun, drawn to scale. I scarcely need the aid of distinguishing letters to denote the various arrangements and appliances, as I think they cannot fail to be clearly understood by practical seamen; I have only shown one tackle, as that appears sufficient to illustrate the mechanical arrangement of the whole. The gun is represented as being run out. The side tackle, it will be seen, leads through the block in the ship's side in the ordinary way, but instead of returning inwards to be pulled upon by men; it goes through the deck, to and round a windlass on the deck below; another view of which appears in Fig. 2, showing also the two windlasses or drums which would be required to work a gun, and the necessary number of ropes for the operation. In this Plate, too, an outline of an engine appears placed on the orlop, and, of course, underneath the water, and out of the way of shot, which engine communicates motion to the strap above; this also is put underneath the water line. Now, the manner of operating on this arrangement is this—so long as the ropes round the windlasses are slack, or at least no great strain upon them, the windlasses revolve within them without affecting the tackles, but directly the end of any of the ropes is pulled upon, the windlass instantly nips the rope so pulled upon, which is dragged downwards, and consequently draws the gun in the direction of the rope so dragged upon; for instance, if it be wished to run the gun out, the end of the running-out tackle is pulled upon by one or two men, and the gun instantly follows it out to the port. Again, if it be wished to train the muzzle left, the train tackle, or rope representing it on the right side of the carriage, is pulled upon, when

E GUNS BY STEAM POWER.

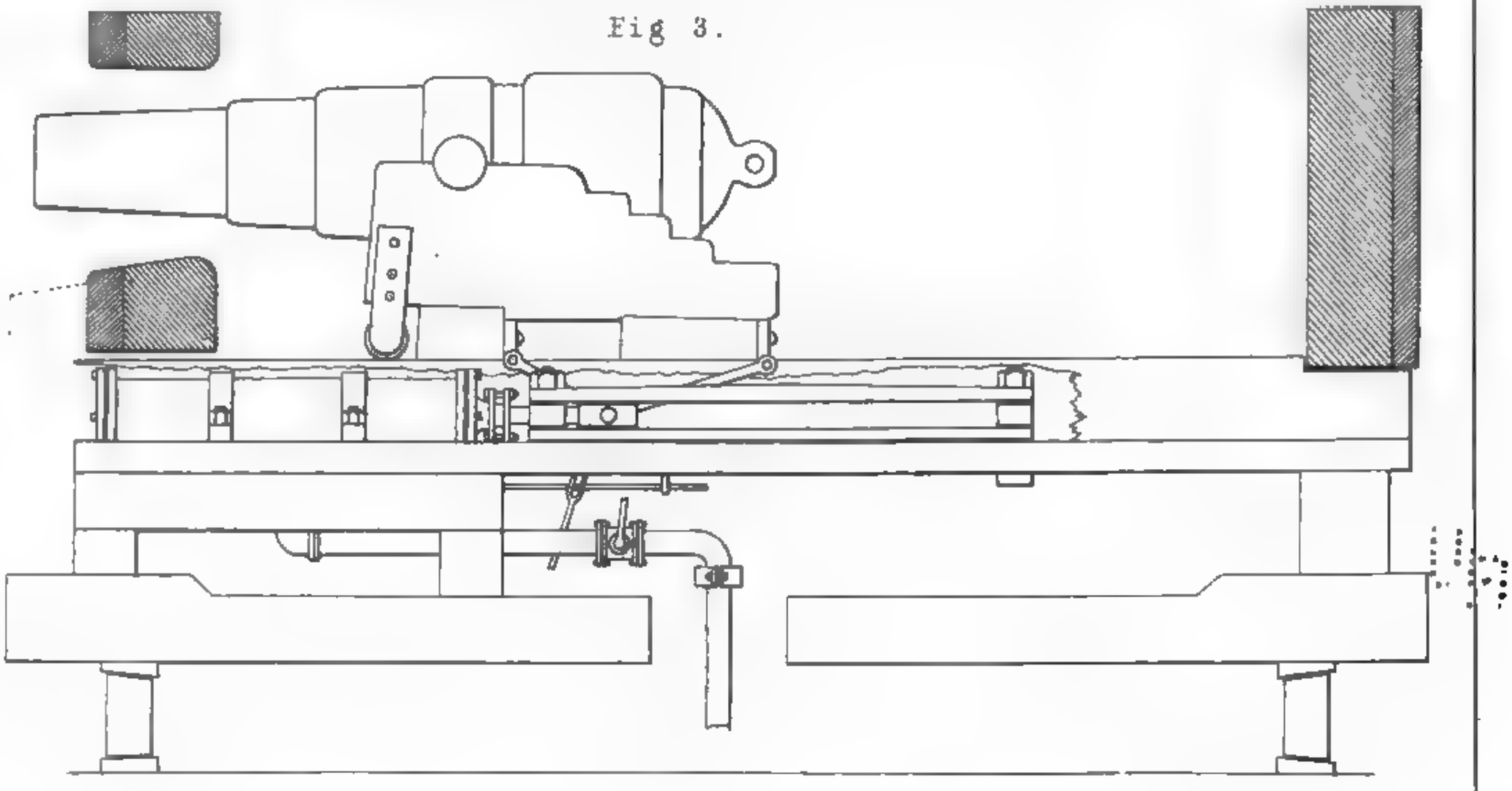
Fig. 2.



J R Jobbins

Mr CUNNINGHAM'S METHOD OF WORKING TURRET OR CUPOLA GUNS BY STEAM.

Fig 3.



the gun is trained accordingly. In the drawing, the ropes are represented as working the gun from the deck below, but by leading them up again through the deck and over blocks, the ropes can be operated upon on the gun deck. My impression, however, is very strong in favour of working the guns as much as possible from the deck below, so as to remove as many men as possible from the fighting deck, for the reasons before given. In the model which I am now about to show you, it will be seen that I lead the train tackles to the fighting deck, but keep the running in-and-out ones below. In these days of telegraphy there can be little doubt but that communication can be arranged between the two decks. In conclusion of my description of this form of my invention, I would again refer to the prospect of its being impossible to render a ship's side invulnerable to shot. If this should be the case, then are we not in the same position that we were in the good old days of wooden walls, and, probably, worse; and may it not become a question, if it will not be better to return to them again? Adopt the measures I now propose, to expose as few men as possible to danger on the fighting deck, and let the shot go slap through the ship.

And now we come to the cupola. In this form of mounting and working guns, the application of steam power in the manner proposed by me, and which I am about to describe, affords great security to the guns, and in many ways brings the gun under such complete control as to encourage the firm belief that a gun could, under these conditions, be worked in the heaviest weather. Referring to Plate VII, Fig. 3, you will, I have no doubt, be able to follow me without distinguishing letters, and see that between the slides I place a steam cylinder firmly secured to a plate and bed-piece. The end of the piston-rod works between and in strong guide bars, firmly bolted down to the bed-plate, over and upon which lay the sides of the slides, the ends of which go under the structural part of the turret. I am particular in calling your attention to this, as I want to show the security which is given to the bed-plate by this arrangement. Now, from the end of the piston rod are two connecting rods, the respective ends of which are bolted to plates on the fore and rear chocks of the carriage. The steam pipe I lead up through the hollow axis of the cupola, and the throttle valve and D valve levers are conveniently placed for the working engineer to have command over both. In the diagram, for the sake of showing their existence distinctly, I have represented them vertically, but they probably would not be placed in that position, but horizontally, as in the model. Now, here we have the material arrangement of my plan for applying steam power to turret guns. The practical working needs but slight explanation, for it will be readily understood that by the alternate action of the valve lever the gun is moved backwards and forwards on the slide, as I now practically exhibit on this model. You will also perceive that when the gun has been run out by the pressure of the steam, unless the valves are reversed it will remain out; and, again, should it be in for loading, when, of course, it will be desirable to keep it in for that purpose, so long as the steam is kept on at the other side of the piston,

the gun will remain in. I also contemplate employing the steam as a cushion to check the recoil. I cannot see at present any practical difficulty to it; but even if that should not be found desirable, I have provided a more powerful brake, or compresser, which will serve that purpose. Should, therefore, the steam not be used to check the gun at the moment of firing, the steam will be cut off, and the gun will then run in in the ordinary way, the steam remaining in the cylinder, acting most beneficially in checking recoil, and it may probably prove sufficient for the purpose. I further contemplate that the movement of the gun will be so entirely and completely under control that instead of using the sponge and rammer in the ordinary way, the gun shall be made to sponge and ram itself. I will now call your attention to the points of security and power of action which I obtain in this form of my application of steam power to working guns. You will observe, in the first place, that in consequence of the gun carriage being tied down to the slides by the two connecting rods, the secure way in which the guide bars are bolted to the bed-plate, the impossibility of the bed-plate lifting on account of the slides with the gun on the top of them keeping them down, and then the turret itself keeping the slides down, that be the motion in the ship ever so violent, yea, let the ship be even almost reversed, the carriage cannot be disengaged from the slides. Again, the power of working the gun in the heaviest weather and most turbulent sea, would be almost unlimited, with a 15-inch cylinder, and steam, say 45lbs., we may estimate that a prime pushing power of about 3 tons would be obtained, which I think we may calculate would be sufficient to start the gun and drive it up a considerable inclination. Thus then in the heaviest weather, so long as the steam were up, which could be accomplished quickly, as it would not require a very large steam generator, the guns could be securely and surely worked.

And now, before closing, I would remark that soon after I had taken up the consideration of this subject, I discovered that the question did not rest with the mere moving the guns about, that the increased weight of projectiles, and other considerations regarding the growth in the size of ordnance pointed out the necessity of a reorganization of all mechanical armaments for working guns, from the magazine upwards. I was irresistibly drawn into this; one thing led to another, until I could cover the table with models of designs for the service of shot and powder, training of guns, checking the recoil of guns, means for lowering and raising the level of guns in cupolas, and many other details relating thereto, all of which are now officially under the consideration of Captain Cooper Key, and all, if not most of them, must be adopted in some shape or an other. It would have been impossible, however, to have included them in the present paper. I have, therefore, strictly confined myself to the text of it, viz., "the application of steam power to the working of heavy guns."

Rear-Admiral HALSTED: I should like to ask Mr. Cunningham one question. I do not know whether he has included the working of the cupola.

Mr. CUNNINGHAM: No; I have confined myself simply to the question of working guns.

Admiral HALSTED: I hope you will give your attention to that.

Mr. CUNNINGHAM: I have done so.

Admiral HALSTED: Because it is a thing still more inevitable than the other.

Mr. CUNNINGHAM: I have done so; but this evening I have confined myself simply to the working of the gun. I think I have also made a great improvement in the working of the cupola.

Admiral HALSTED: I think you are hitting the right nail on the head very hard, and driving it very considerably home, no doubt, whether for broadside guns, or cupola guns; but there is the further consideration, which I have referred to. It is quite a consideration as to whether the cupola vessel of the Danes, which they have had since June last, the double cupola vessel, which probably is now very hard at work at Alsen, whether she should not have been fitted with steam to work her cupolas; it will inevitably come to that.

Mr. CUNNINGHAM: Capt. Coles reports so favourably upon the manner in which he can move the turrets in the "Royal Sovereign," with manual power, that although I had provided a simple arrangement for moving the turrets, the result of his cog-machinery seems to be so very good, that I have not gone on with mine.

Admiral HALSTED: Already I think the working of the gun in the cupola gives immense power to it. I may mention that he (Capt. Coles) ultimately contemplates employing steam; but at present he is content with putting the thing forth on the original system, by employing manual labour. I am sure you will give all the assistance you can, because I think that the cupola is the true ship of the future.

Capt. CHADS, R.N.: You will keep the shaft shown in Fig. 2, and which works under the gun, along the deck, going throughout the action; you hold on, I suppose, when you want to work it?

Mr. CUNNINGHAM: Yes; and that shaft is always going round throughout the action.

Capt. CHADS: Does one engine work the whole of the broadside guns, or have you a number of small donkey-engines?

Mr. CUNNINGHAM: Supposing we are dealing with vessels with eight guns on each side, we should have two engines, one at each end of the battery, or two engines amid-ships, connected with each other by a shaft.

Capt. CHADS: Do all your tackles go to one shaft, your side tackle and your tackle for training the gun?

Mr. CUNNINGHAM: Yes.

Capt. CHADS. That may be ingenious in the model, but I do not see how it can work in practice. I do not see how you could take all your tackles to one shaft.

Mr. CUNNINGHAM here worked the model, to show the possibility of its being done.

Capt. CHADS: How many tackles have you at work?

Mr. CUNNINGHAM: I propose to take the present form of carriage, which I fancy will be the one adopted in heavy guns. In this form of carriage you have two fulcri for your two tackles. I am obliged to give new names for them. I call them my running-in tackle, and my running-out tackle. I avail myself of this carriage to obtain means for working one tackle for running in, and one for running out.

Capt. CHADS: Do all of those four go to one shaft, and do all four remain on that one shaft all the time?

Mr. CUNNINGHAM: Yes; but you will understand when the falls are slack, the windlasses revolve inside the rope without affecting the tackles. As you see I am turning this windlass round, it does not affect the tackle at all; I have one or more men to each fall, and I call them the running-in and running-out tackle.

Major LEAHY, R.E.: You say you might have one or more men to each fall; supposing, however, that in action, the gun was being run up, and that by accident, both training falls were worked at the same time, would not that create confusion?

Mr. CUNNINGHAM: I think the result of that would be, that the one who holds on the best, would drag the falls out of the other man's hand.

Major LEAHY: Talking of the gun being under the immediate control of the captain, I doubt whether the men working down below would really be under the immediate control of the captain during the heat of an action?

Mr. CUNNINGHAM: Some system of communication must be established between the two decks; and as I mentioned in my paper, I have no doubt in these days that some system will be devised. I have already a plan for communicating with the two decks, which I think might easily be adopted, because, in communicating with the engine-room now, there is no difficulty at all.

Major LEAHY: In fighting the gun, you must remember, that there is a great deal of excitement.

Mr. CUNNINGHAM: If you found any difficulty at all, you could bring the whole of your tackle on the upper deck, and have the whole of your men under the immediate control of the captain.

Major LEAHY: The next point I wish to come to is this, you must have a certain number of men on the fighting-deck to load the gun. A six hundred-pounder would require a certain number of men to load it; I do not know how many.

Mr. CUNNINGHAM: I do not wish to cut down the number very close, but I calculate that the twelve-ton broadside gun would have six men on the fighting deck. It would not take more, and that would be a great reduction; for that gun will require, at least, thirty men to work her at sea. And, of course, if you can take 24 men away, it would be an immense gain.

Major LEAHY: Quite so; but you must have at least six to load and ram home.

Mr. CUNNINGHAM: You will understand that I provide great assistance for loading the gun in the plan which I have before alluded to, and for conveying the projectile to the mouth of the gun. I have provided plans for that, and also for the conveyance of the powder. The weight of the powder is not, however, so important as the projectile, which is certainly the most important thing, because it is immensely heavy. With regard to the spherical shot, two men can manage that easily enough. I say easily enough, but they are obliged to land the shot on the plate in front of the gun, and it requires a great effort to do it, but still it is done, but with the elongated shot it is quite another affair.

Major LEAHY: It appears to me that you must have a certain number of men on the fighting deck to load the gun, and that the gun will be more under the control of the captain by having the men to work the tackle on the same deck. I apprehend there will be a difficulty in getting it under complete control by having the men to work it on the under deck.

Mr. CUNNINGHAM: You can lead the tackle up through this deck by simply having another block.

Major LEAHY: Have you thought of applying the system to a fixed battery?

Mr. CUNNINGHAM: Yes; the only difficulty is, that in an extended battery you will require such long shafting. I fancy the system is more applicable to ships than it is to batteries, unless in the case of such compact forts as those building at Spithead, where the guns will be close together; and then I dare say the shafting might easily be carried through.

Major LEAHY: I do not think it should be assumed that we shall not improve the carriage. I think that it is very desirable in an arrangement of this kind, when you commence to apply machinery to a gun, to consider whether you cannot so apply it as to pivot the gun at the muzzle. Of course, in using these large guns, if you can apply mechanical power so as to give elevation and depression of the gun as well as training, it will be a great point gained.

Mr. CUNNINGHAM: In the 12-ton guns on board the "Excellent" there is a beautiful plan for elevating and depressing. I had myself devised a plan, but I have given it up in favour of that plan. It consists of a rachet working inside the brackets of the carriage. It is very quick in its motion; one man can elevate and depress the gun with the greatest ease. There has been one thing adopted with these heavy guns which assists the operation; they are poised better than the old guns, and there is not so much preponderance of weight at the breech.

Major LEAHY: So long as you pivot from the trunnion instead of from the muzzle, you must provide a larger port than you would otherwise require; if you could pivot the gun from the muzzle you could reduce the size of the port. It is a matter that has been under the consideration of some persons, and plans have been proposed for pivotting guns at the muzzle.

Capt. JASPER SELWYN, R.N.: I have the greatest pleasure in rising to give, as the first thing, a due tribute of praise to Mr. Cunningham, and to say that I am sure it is the conviction of every one who has been listening to him, that he has not fallen from the fame he has so justly acquired in other directions of saving labour. He has shown us a most ingenious and practical mode of doing that by simple machinery which it had been often supposed could only be effected by complicated machinery. It is true that there still remains the objection, which I am sure he won't underrate, that, if shot come in, no matter how simple the machinery, yet it is liable to destruction; therefore it would not be wise to abandon the armour when we increase the delicacy of our machinery, or, on the other hand, to rely entirely on any machinery. In a great measure this has been attended to here. I regard it as one of its chief excellencies that you can apply the ordinary tackle to these guns in case of the mechanical appliances, which he has explained to us, being destroyed by a shell or spherical shot, which we are beginning to learn make no more account of five or six inches of armour-plate than the old cast-iron shot did of the wooden ships. Mr. Bessemer has promised us nine inches of armour-plate, if we will only consent to use steel for our ships instead of iron. Therefore I think Mr. Cunningham may still continue to believe in the efficacy of armour-plates to keep out shot. That he should economise the risk to life is a most delightful circumstance to every Christian. It has been done by him to a very great extent in the reefing of sails aloft; he is now proceeding to carry out the system below. I have a few words, however, to say about its adaptation to the cupola. In the first place, I say that the steam-pipe must necessarily have a moveable joint. It must come up through the central shaft of the cupola, and as the cupola is trained round, you will see the steam-pipe must necessarily move round in its gland. Now, the working of the cupola, however it may be made, is yet a serious question; and it is open to doubt, whether that joint could be efficiently kept water-tight during the roll of the vessel and the working backwards and forwards of the heavy gun. I am sure, however, that with Mr. Cunningham's mechanical skill, he will not leave that point unattended to. The next thing is with respect to the cupola. I do not think, though some of my seniors have praised it, that it is *the thing* of the future, simply for the reason that you must fire through your own decks in many instances. If your ship is heeling, there is no possibility of firing on a level from a large ship with your cupola in the centre without firing through your own deck. Secondly, the cupola adopts and insists upon the principle of putting a very few eggs, and those of a large size, into one basket. It cannot be cheap to make a vessel of 6,000 tons to carry six guns, however big they are. You may put the same number of guns into a smaller vessel and adopt those appliances, as I have no doubt will be adopted, and you will not require so large an expenditure. I think that the public would be very ill-pleased to hear that half a million of money had been lost in running after a "Monitor" over shoals on the American coast. The method of working guns by *communication*, of which Mr. Cunningham has spoken, seems to me to present one of its greatest difficulties, if we leave out the consideration of gun-cotton. If we get rid of the smoke, as gun-cotton promises to do for us, then pointing the gun becomes possible which it is not now; for the finest sights, and the most careful man, and the most accurate pointing are all thrown away when once you get into broadside action. If we get gun-cotton, then pointing may come into play, and have its due weight, and in that case accurate and rapid communication between the captain of the gun, whom Mr. Cunningham has fitly said is the intelligence of the gun, and his subordinates is absolutely necessary. Electricity would be scarcely attainable for such a purpose. It is true that the captain of the ship may communicate intelligence by means of electricity, as has been beautifully done by Mr. Gisborne; but I should be sorry to trust to that beyond a certain limit, arising from that of which I have been speaking—the delicacy of the machinery. It applies equally to the electric batteries; because as you are all aware the wires may be very easily severed by splinters, and your communication then comes to a stand-still. Therefore, you cannot entirely trust to that, and some more simple means is required for that purpose, as well as for the training of the gun. There is, of course, also a difficulty arising from the captain of the gun being separated from his men; he does not see what is happening below, if

a shot comes in. I utterly deny that in any armour-plated vessels that we have, or that the French have, rolling, as Admiral Paris describes them, six or seven times a minute exposing many feet of undefended bottom, I utterly deny that there is any security whatever against shot. I won't say against all shell, the armour-plates are safe. Mr. Whitworth has demonstrated that they may be pierced; but I attach very little importance to that, because if a spherical steel-shot is capable of breaking any large portion of an armour-plate into fragments, that is quite as formidable as any shell that can be projected through armour-plates. The general praise I, as a naval officer, beg to give to the whole arrangement is, therefore, qualified by very few and unimportant matters; and I am quite sure that I may sit down fully aware that Mr. Cunningham will bring much greater science and skill to the eliminating of those difficulties than I could possibly suggest.

Commander COLOMB, R.N.: Is it necessary to keep the drums of the shaft polished on which those ropes are run? Because they are obliged to keep them polished in using them for hauling up timber and matters of that sort; and a very little roughness is sufficient to give friction to hold the rope when not intended.

Mr. CUNNINGHAM: No; I should think not.

The CHAIRMAN: It is a question of detail, and very simple.

Commander COLOMB: With reference to the revolving joint, I do not think we need fear about that, seeing that Penn's oscillating engines do a very great deal of work upon the same principle.

The CHAIRMAN: I think the subject before us a very important one. It is quite clear, that with such very heavy guns there will be very great danger where ships roll so fast and so far; and it is desirable to have something more specific and trustworthy than mere manual labour. Of course, difficulties will arise in every mechanical arrangement; but the question to consider is whether the difficulties you have to contend with at present are not greater? It appears they are. I have often found it myself; and we all know very well, from the experience of the experimental squadron, that the men lost entire control over the guns. They turned quite round, upset, and did all sorts of things when the ships were rolling. It was not simply the fault of the carriage itself. Though, with a different description of carriage, the same thing could not precisely occur that occurred in this instance, still the gun would get beyond the entire control of the men. I think that much less difficulty would arise from this plan of Mr. Cunningham's than from those mentioned; but at the same time I am of opinion that this is a question which ought to be considered, whether we are not taking too much for granted in supposing that it is necessary to have such *very large guns*. I am quite sure of this, that it would be much more important if the public mind were set in the direction of making *smaller guns more efficient*. I am quite sure that they will do more than has been done. We see in the case of Mr. Whitworth, with his small calibre, what very great work he does. I believe that the arguments that we have heard here, about the great effectiveness of the large calibre guns is a mistake. I am confining myself simply to the charge as it was illustrated by Sir William Armstrong and Mr. Bashley Britten, the latter of whom was arguing the surperiority of his gun over Sir William Armstrong's, by showing that the calibre was larger; and, therefore, that he got a larger surface for the charge to be acted upon. But if he did get a larger surface, he got a larger charge to destroy his gun. A large portion of the greater effectiveness of Whitworth's gun arises from the fact that he has got a large charge which takes a long time to exert its power, and gets greater effective power without injury to his gun. If that principle were applied to guns of small calibre, it would not be necessary to introduce these very large guns. And the same objection occurs with respect to the very large guns that are to be in the cupola, where, as has been said by Captain Selwyn, "you have all your eggs in one basket." We have seen, in America, the disadvantage of having only one gun in a vessel. When it gets out of order, then the great vessel is entirely disabled. I believe it is much better to have a larger number of chances. The vessels would then be much more effective, and you would get a greater result by a vessel armed with a number of small, but still effective guns, than you would possibly obtain by a few guns of a much larger calibre. Furthermore, it is a very important consideration, that the smaller the gun is, the greater probability

there is of its long life. This is a very essential point. In proportion as you get larger guns you increase your difficulty of endurance. I am sure you will allow me to return your thanks to Mr. Cunningham for his valuable paper. Like all pioneers, his work will expose him to a kind of target practice in the way of cavils, objections, and difficulties that will be raised; but he is entitled to our great praise for having devised the system, and still greater praise that he has matured it so far as he has. In closing, it just occurs to me to ask whether you think the action of the recoil is so sudden that it would not be liable to damage your piston-rod and injure your gear?

Mr. CUNNINGHAM: The guide-bars within which the piston-rod works, are tied down so securely, that the rod could scarcely be injured by the recoil.

a shot comes in. I utterly
that the French have, rollin
minute exposing many fe
any security whatever ag
plates are safe. Mr. Whif
attach very little importa
of breaking any large p
as formidable as any shel
praise I, as a naval officer
by very few and unimpo
aware that Mr. Cunni
eliminating of those dif

Commander COLOMB
on which those ropes
using them for haulin
ness is sufficient to g

Mr. CUNNINGHAM

The CHAIRMAN:

Commander COL
fear about that, se
upon the same pri

The CHAIRMAN
clear, that with a
roll so fast and s
worthy than mer
arrangement; b
contend with at
it myself; and
squadron, that
upset, and did
the fault of th
the same thin
gun would g
difficulty wou
but at the
considered,
necessary to
much more
smaller gun
done. We
great work
the great ef
simply to th
Britten, the
Armstrong'
larger surfa
got a larger
Whitworth
long time
gun. If th
sary to intr
to the very
Selwyn, "
disadvanta
great vessel
chances. T
result by
you would
is a very in

Evening Meeting.

February 20th, 1864.

E. J. REED, F.R.S., in the Chair.

between 16th and 29th February

ANNUAL.

Talbot-Harvey, W., Major 1st Middlesex Engineer Volunteers, 1*l.*
Liddell, W. H., Commander R.N., 1*l.*
Percival, H. L., Lieut. R.N., 1*l.*
Pooley, Hy., Capt 3rd Ches. Art. Vol., 1*l.*
Farquharson, G. Mc.B., Capt. 20th Rt., 1*l.*
Traill, Wm., Assist.-Surg. 91st Highldrs.
Prendergast, G. A., Capt. 5th Ben Cav., 1*l.*
Gregson, Jas. D., Ensign 40th Regt., 1*l*

SHIPS—THEIR ADVANTAGES DEFECTS.

JASPER SELWYN, R.N.

before you some remarks on the
ress in the nature of those vessels.
s carried on—the true walls of Old
ren, whether scientifically propelled
the winds of heaven.
he almost certain concomitants of
sam, but it is the province of science
ess and to prevent, if possible, their
to give, so far as I am able, a due
ved from armour-plating and other
the defects, ascertained or theo-
ssity reconstruction of our navy, or

e able to give praise than to be com-

Evening Meeting.

Monday, February 29th, 1864.

Colonel P. J. YORKE, F.R.S., in the Chair.

LIST of MEMBERS who joined the Institution between 16th and 29th February

ANNUAL.

Disney, E. J., Capt. Sussex Rifles
Potts, W. J., Ens. 23rd Mdx. Rifle Vol. 1*l.*
Clay, T. S. Lieut. 103rd Roy. Bom. Fus.
Pickwoad, E., Lt.-Col. St. Kits Militia, 1*l.*
Collett, H., Lieut. Bengal Staff Corps, 1*l.*
Bassett, W. W., Capt. 56th Regiment, 1*l.*
Boyle, Alex., Capt. R. N., 1*l.*
Hughes, A. C., Lieut. 2nd Life Gds.
Hore, E. G., Capt. R. N., 1*l.*
Talbot-Harvey, W., Major 1st Middlesex Engineer Volunteers, 1*l.*
Liddell, W. H., Commander R.N., 1*l.*
Perceval, H. L., Lieut. R.N., 1*l.*
Pooley, Hy., Capt. 3rd Ches. Art. Vol., 1*l*
Farquharson, G. Mc. B., Capt. 20th Rt., 1*l.*
Traill, Wm., Assist.-Surg. 91st Highldrs
Prendergast, G. A., Capt. 5th Ben. Cav., 1*l*
Gregson, Jas. D., Ensign 40th Regt., 1*l.*

ON ARMOURED OR IRON-CLAD SHIPS—THEIR ADVANTAGES AND DEFECTS.

By Captain Jasper Selwyn, R.N.

It will be my task to-night to lay before you some remarks on the great change which is now in progress in the nature of those vessels by means of which naval warfare is carried on—the true walls of Old England, whether built of wood or iron, whether scientifically propelled by steam or driven less certainly by the winds of heaven.

Great errors are, unfortunately, the almost certain concomitants of great and sudden changes of system, but it is the province of science to take early note of such errors, and to prevent, if possible, their recurrence; therefore, I am about to give, so far as I am able, a due weight to the advantages to be derived from armour-plating and other changes, but more especially to note the defects, ascertained or theoretical, which may retard the speedy reconstruction of our navy, or render it unduly expensive.

It is always more pleasant to be able to give praise than to be com-

Names of Vessels	Tons	Horses Power Nom.l	Guns	Plat-ing	Backing
BELLEROPHON	*4246*	1000	*14*	6"	10" Wholly Plated
WARRIOR BLACK PRINCE	*6109*	1250	*40*	4½"	18" Partially Plated
DEFENCE RESISTANCE	*3720*	600	*16*	4½"	18" Partially Plated
HECTOR VALIANT	*4063*	800	*32* *34*	4½"	18" Wholly Plated
ACHILLES	*6080*	1250	*35*	4½"	18" Partially Plated
MINOTAUR AGINCOURT NORTHUMBERLAND	*6621*	1350	*50*	5½"	9" Wholly Plated
PRINCE CONSORT CALEDONIA OCEAN	*4054*	1000	*35*	4½"	8" Partially Plated
PALLAS	*2372*	600	*6*	4½"	7" Plated
ROYAL OAK ROYAL ALFRED	*4056*	800	*35*	4½"	8" Wholly Plated
ROYAL SOVEREIGN *Turret*	*3963*	800	*5*	5½"	17" Plated
PRINCE ALBERT *Turret*	*2529*	600	*5*	4½"	18" Wholly Plated
ZEALOUS	*3716*	800	*20*	4½"	8"
FAVORITE	*2186*	400	*8*	4½"	10"
RESEARCH	*1253*	200	*4*	4½"	6"
ENTERPRISE	*990*	160	*4*	4½"	6"
LORD WARDEN LORD CLYDE	*4067*	1000	*36*	4½"	10"

J R Jobbins

pelled to blame, and I shall, therefore, commence by acknowledging the great progress which has been made in the construction of armour-plated vessels since the days of the "Meteor" and "Trusty," and particularly the great improvement in certain qualities, as shown in the "Bellerophon." The "Meteor" and "Trusty" class were little, if at all, less awkward under their load than some of the extraordinary craft with which our transatlantic cousins have astonished and amused all who know what naval structures ought to be. The Americans had, it is true, a peculiar work to do, in their great rivers, and along their shallow-water shores, and we suppose they are satisfied with the very peculiar structures which they built to do it, but we should be sorry to see any imitation of them in England, for whatever else the "Monitors" may answer for, it is certain that they will not do for the ocean.

The advantages which should be obtained from an iron-clad vessel are evidently, if she is worth building at all, an absolute resistance to shell, and considerable resistance to shot. More than this, no vessel is fit for war if, when rolling or heeling over, shot and shell can be sent through her bottom, and so, or by a blow from a ram, she may be immediately sunk.

Unhappily, shot are little less destructive than shell whenever they do pierce iron plates, for the number of pieces into which the interior part of the plate is driven, together with the rivets, nuts, bolts, &c., form a species of langridge, the effect of which is not less to be feared in a crowded deck than that of the most formidable shell.

Now, I believe that no one here will wonder that I should have been puzzled to find out many other advantages than those I have stated as theoretically obtainable from armoured ships. They are certainly not more comfortable to live in, and undoubtedly they cost much more than any previous form of vessel. Where wood backing is used it is doubtful if they are much more exempt from decay, while it is quite established that they are much more "lively," and "liveliness" means disintegration, when it is used to express the rapid motion of a vessel at sea.

And even when wholly constructed of iron, there is, as I shall presently show, an insidious force at work which mocks the puny efforts of man to give the character of real durability to any of his structures. I speak of electricity, whose effects, though they cannot be entirely prevented, may yet, by care and attention, be considerably diminished. As then it appears that the principal, if not the only, advantages of armoured ships are those which I have alluded to, it behoves us to inquire whether we have got the greatest obtainable measure of them for our money. The accompanying Plate VIII shows the size, power, and armament of 25 vessels with the thickness of plating, backing, &c., to each.

First. Do existing armour plates up to 5½ inches give us entire protection against shell? I think it may safely be asserted that they do,—for though Mr. Whitworth has been able to puncture armour with shell, no shell effects followed, for none of the pieces pierced the lining of the vessel.

But there is no doubt whatever that a properly-constructed smooth-bore gun, or a rifled gun capable of firing spherical steel shot, can be made, of no greater calibre than the 8-inch, which will drive its shot through any 5½-inch plate, however backed by wood. It may be said that no effect like this has yet been produced, I answer that a fair inference may be drawn, that if the 110-pounder smooth-bore could do what it did at Portsmouth, with such a charge, then a gun (of steel or alloy), capable, without injury, of firing a full third of the weight of its shot as a powder charge, ought to and probably will do what is here claimed. At any rate an increase of calibre to 9-inch or 10-inch, which is by no means impracticable even for broadside guns, will give us all the power required to penetrate 5½-inch plates. In short, it is almost certain that except, perhaps, the "Bellerophon," no ship now built or building could resist such an attack even from single guns, far less from a broadside concentrated on a single plate; and I do complain, that not only has not proper attention until lately been given to the effects of smooth-bore guns and spherical steel shot, but that no experiment has been yet tried which gives any idea of what would be the effect of a concentrated broadside from a vessel like the "Warrior" on armour-plates. It would, indeed, be lamentable if, after the vessels now under construction have joined those which are afloat, the nation were to be told that they, like their sisters, were "errors or mistakes." I quote from the speech of the chief constructor as published in the *Times* of 27th November last, and so far as protection against shot goes, he is certainly not far wrong. But I cannot believe that he really expects to get anything like high speed, 14 to 16 knots, out of materially shorter vessels with the single screw, all other conditions being equal, while the handiness he seeks, with many other good qualities (speed included), may be given to any ship by the use of twin-screws, as advocated so long and so ably by Commander Symonds.

There are certain desiderata in a man-of-war which almost amount to *sine quâ non.*

The first of these is high and lasting speed united to good manœuvring power, for without these the weakest ship may, in these days of steam propulsion, set the most formidable at defiance. The second is a great degree of unsinkability. The third is comparative safety to life in combat. The fourth is durability.

We will now proceed to consider these seriatim, and, according to their value, pointing out how far they have been secured, and what farther means are available in order to obtain them in the highest possible degree.

High speed can be obtained by two means. Improvement in the form of vessel, or improvement in the motive power. Of these by far the most valuable is the first, for as the resistance increases in some ratio nearly approaching the cubes of the velocity, it follows that to double the speed of any given vessel you must nearly cube the horse-power. Accordingly, as might have been expected, attention has been constantly given to the improvement of the lines of floating structures, and it would seem to be little short of folly to ignore or

deny the value of great length, evidenced as it is by the performance of every modern vessel.

But if we have attained the limit beyond which we cannot go in this direction, without incurring other inconveniences which are too serious, we may at least consider whether, in the case of motive power, we have also arrived at a boundary which it would be unwise to pass. To double the area of the screw by placing two under the counters, or still better in double keels, instead of one in an aperture in the dead wood is not only to give a greater area of push against which the engines may at all times usefully exert their power, but also to place the screws where the water will most freely arrive at and depart from them, and I cannot understand why something more than a launch or a gunboat has not by this time been built by the Government, after having so many opportunities of seeing, in merchant ships, strong confirmations of the value of the principle. I am sure that in the "Enterprise," if she is to be anything but an enterprise of sluggishness, some such trial might usefully have been made, for with a contemplated speed of 9 knots (and it is seldom that the "contemplated" speed is reached in practice), she will be a bore to her friends, and a laughing-stock to her foes. Many an impatient puff of steam and temper will come from the squadron or fleet which has to tone down 12 knots to 9, in order to keep pace with the slowest top of the day.

But speed may be high yet not "lasting," from several causes. First, small fuel-carrying power; here, experiments ought to be in progress to ascertain the best sort of fuel—the best way of carrying and using it Petroleum, as fuel, has received so high an encomium from the American engineers appointed to examine into its use on board steamers, that it ought immediately to be inquired into in this country. Also the best form of boiler, and economy of heat should be always under examination; and when I speak of experiments I do not mean building a 6,000 ton vessel costing half a million, to see whether she will steer like a boat, or trying whether from one particular gun a shot costing £50 can be made to pierce a target costing £5,000, but experiments worthy the name, such as Count Rumford or Colonel Beaufoy, might have superintended with pleasure, and men of science of all future ages might appeal to with confidence. Who can say that this is now the case? Who can read the accounts of, or see the results from the Shoeburyness practice-ground, without feeling that these are attempts to prove foregone conclusions by whatever means,—not step by step, well directed, straightforward searches after truth. Has a single principle been established? Do we know the best relative thicknesses of armour and backing? Do we know anything on the subject as we ought, considering the money and time spent, except that there are certain guns of which we have made a great many that are not safe to use? and a certain thickness of armour which covers John Bull's best ships, which almost any steel shot can pierce.

To return to the subject of speed: besides being short of fuel, there is the fouling of the bottom, which may prevent speed from being lasting. The problem of keeping a ship's bottom clean, is one of the

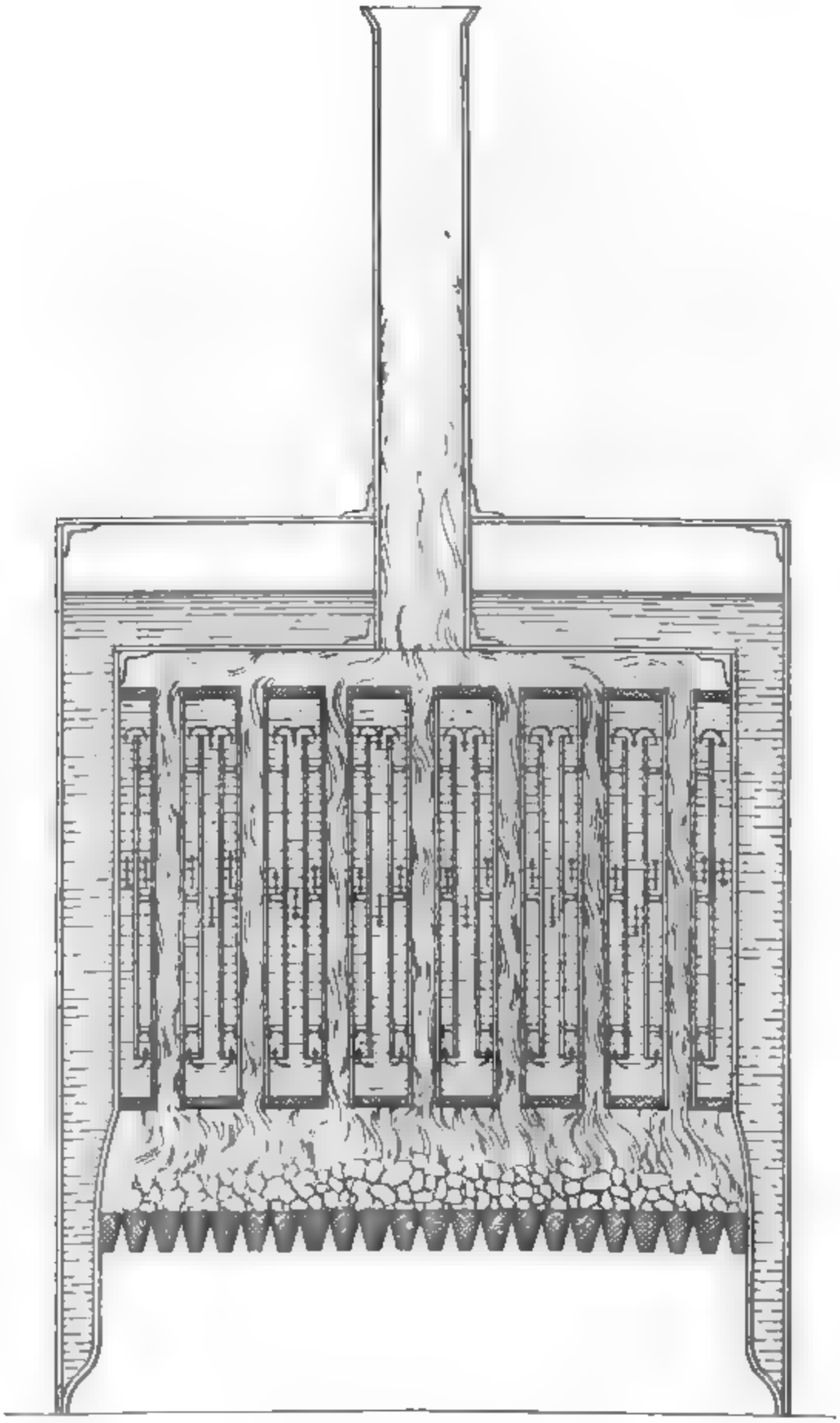
very greatest importance, and I have for a long time been examining what has been or might be done in this direction.

We have first to lay down the principle, that no substance ought to be used such as zinc paint, or other mixture which may exert an injurious galvanic action on the strength of the ship, if built of iron: secondly, that any application to be valuable, must possess one of two qualities; either, like copper, it must renew its surface by slow corrosive action, or like mucus it must be capable of remaining fluid, yet without washing off. If neither of these can be secured, then it must be such a substance, so applied, as that its renewal can take place constantly, or during a sea voyage. Now, with iron ships copper is out of the question; there is no possibility, short of casing the entire ship by the galvano-plastic process, of preventing the excitation of a galvanic current, and the consequent rapid decay of the iron, which is the inferior metal in this galvanic couple. Even if the metals could be separated, the salt water would act as a conductor, and we have to deal here with enormous quantity, though low tension; therefore copper, or any other sheathing which is of metal, or includes metallic compounds, higher or lower in the galvanic scale than iron, is inadmissible. If we were to be contented with any paint of any sort, perhaps ordinary coal-tar would be the best and cheapest.

But let us consider the question of a mucous substance. This is the means which nature adopts to preserve fishes from incrustation; and I have long ago had occasion to observe, that diseased whales and other fish which have lost the power of secreting this, speedily become covered with barnacles and the other shells and weeds which generally attach themselves to a ship's bottom. Is it possible to obtain a substance which shall have, when put on metal immersed in salt water, the characteristic of insolubility, combined with sufficient adhesiveness to remain on, and enough sliminess to prevent the deposition of the young shell-fish, and the germination of fuci, &c. I think it is possible to find such a substance, but if not we might consider that oil and grease do, at their issue from the bilge-pumps and blow-offs, get rubbed against and clean a ship's bottom during their upward passage to the surface of the water, forced as they are against the bottom by the pressure of the column of water which supports the ship. I do not think it difficult to provide for the issue of the oil near the keel, of course under pressure, and so for its general distribution over the bottom of the ship; but supposing a chemical substance approaching to mucus to be obtainable, I should prefer it, as being probably least expensive and more easy of application.

A few words more on the subject of the application of heat. The present tubular boilers are most defective instruments for heating water economically. There is, first, no provision whatever for the necessary interchange of the currents of heated and comparatively cold water. This might be, and I believe in some instances has been, secured by the use of double concentric vertical tubes, which allow the heated water to ascend between them while the cooler descends outside (see Plate IX). Secondly, it is well known that nothing yet invented will entirely prevent the incrustation between horizontal tubes, that is, on the upper and lower sides of each tube, often making a solid

DOUBLE CONCENTRIC VERTICAL TUBED BOILER.



mass of non-conducting material between what should be the most valuable part of the heating surface and the water. Some change in this direction is most necessary, and I believe the only obstacle to vertical tubes has been an idea, I think not well founded, that they would necessarily interfere with the low position of the boilers supposed to be desirable in a war ship; but if the ships be really and effectively armour-plated, this ceases to be a matter of the first necessity, even were it proved, as it has not been, that high boilers are inevitable consequences of vertical tubes. There is also the coil system, originally Perkins's, in which water enclosed in a wrought-iron coiled tube is brought to a red heat, and evaporates the water in the boiler. Under a modification of this idea, patented by Mr. A. Longbottom, C.E., I find a report of trial published by the Abbé Moigno in a French magazine (*Les Mondes*), which is edited by him, giving results which amount to 15lbs. of water evaporated by 1lb. of coal, the ordinary duty done in our best boilers being 8 to 10lbs. Even these results are not what might be obtained by a better form of boiler than that employed, for instead of making the shell of the fire-box available as heating surface, there was a brick furnace for heating the coil, and a separate reservoir or boiler in which the heating coil produced its effect. So much upon speed and bottom, as I have in a former lecture called the lasting power.

I have said that good manœuvring power is almost as necessary as speed. I know of no more efficient way of obtaining this in the future than by the use of twin screws, or in existing single screws by the use of Mr. Lumley's highly ingenious and efficient rudder. Fins, bow-rudders and bow-screws are alike defective, for whatever water comes to them none can get away clear from them, and they are serious impediments to the use of the ram. But before we can manœuvre these armoured ships, or at least some forms of them, it is necessary that some new means of seeing without too great exposure be devised, and in aid of this I will beg you to look at a prism rifle-sight (a rectangular prism of glass or other transparent substance) which I invented some years since with the view of preventing the necessity which now exists at long ranges in rifle-shooting of raising the cheek from the butt, and otherwise losing steadiness of position in order to fire at long ranges. The result of its use on the top of a cupola or elsewhere is, that it enables your eye, like the Irishman's gun, which shot round corners, to see without being seen.

Let us now turn to the next desideratum in armoured men-of-war, a great degree of unsinkability. It has been improperly assumed that wooden-bottomed ships are more unsinkable than iron, however, constructed. The reverse of this may be shown to be the case. If we take an iron or steel ship and put her upon a rock with the ordinary wave motion in such situations, the iron or steel bottom will be driven in where the rock touches it, but the force applied will very slowly deduct from the general strength of the structure. A hole may be made through an iron ship's bottom, she may have, as in the case of the "Great Eastern," 40 feet in length stripped out of her bottom, and yet little will be taken from her strength. Now I am not going to say

that this point of unsinkability has been left entirely unconsidered, but only that it has not been sufficiently considered in our modern iron-clads. In the "Minotaur," for instance, the bottom is double, like the "Great Eastern," *i.e.*, there are two skins, 2 feet or so apart, and which are divided into cells, and there are longitudinal box girders, which divide the whole length of the ship, together with, I think, 6 transverse bulkheads. But even this, great as the advance undoubtedly is, is far short of what might be done were the material adopted steel plates, and the system one of a congeries of cells, in shape imitating the honeycomb. In every part of the ship up to a line representing the planes of her ordinary inclination or heel, with perhaps the sole exception of engine and boiler space, this system should be carried as far as possible, and then for the first time we should possess a vessel unsinkable by anything but very prolonged violence. I am quite sure that rams will have fearful effects whenever twin screws are used, as I hope they will soon be throughout our navy. No objections can be valid which depend for their sole force on the fact of certain stowage being necessary for certain purposes, and that it has hitherto been obtained in particular ways. Water may be carried as well in fixed cells as in moveable tanks. Provisions and stores must be stowed in subordination to the first necessity, which is that they should not all go together to the bottom, when a big shot catches a rolling ship, or a ram unhandsomely tickles her ribs. We now come to the third advantage specially to be sought in iron-clad ships, comparative safety to life in combat. Without this be largely obtainable, we may as well give up armour plating altogether, therefore we will inquire, What armour do we carry? What armour ought we to carry? What armour can we carry? In answer to the first question, if we except the "Bellerophon," which is no doubt a step in the right direction, no other vessel carries more than 5½ inches of iron over any large portion of her surface, while the "Warrior" and her class carry 4½ only. But the difference between them of 1 inch of iron is more than made up, in fact is believed to be turned in favour of the 4½-inch plates, by the circumstance that instead of the 18-inch wood backing of the "Warrior," the vessels which carry 5½-inch armour have only 9 inches of teak behind their armour. Now the specific gravities of teak and iron are respectively ·750 and 7,264 water, being 1,000, or to put it in other language wrought iron is 7 times heavier than water, and teak is less heavy by $\frac{250}{1000}$, about ¼. Therefore leaving bulk out of the question, and the mode of construction in wood, we can roughly say that we can afford to carry about 7 times as much wood as iron. But it is doubtful whether this is not working in the wrong direction if we consider that the crushing force which good wrought iron will sustain is to that of teak as 25 tons to 6 tons nearly, these being about the respective moduli of elasticity to which the force to resist crushing always bears a just proportion. But with impact to deal with, we have a new element in the calculation. Among the experiments of which I before spoke, most valuable would be a series which should give us accurate measures of the force exerted, say by a steam hammer and punching-machine, in crushing or piercing iron, steel, wood, &c., of

varying thickness, backed by various materials. These would not be expensive, and could not fail to yield most useful information. However, as in the case of metal for guns, we shall be most unwise if we do not try to understand and make use of the metal which *ab initio* promises the best results. Need I say that I point to steel, which may be made at little, if any, more expense than iron by Mr. Bessemer's process, and if used for the hull alone will, he promises us, enable our iron-clads to carry 9 inches of iron, instead of 5½. Now this would be an advance indeed, and surely it is little use proceeding with any more ships, until the value of this assertion be tested. We do carry then from four and a half to six inches of iron armour. We probably can carry nine. Therefore, we ought to carry that, or more, if practicable. I should think that guns have furnished enough specimens of how not to do it without adding ships to the list. Depend upon it that if we do not test these things at home, there are others abroad who will, and it will be too shameful if, after having sent an officer to see guns in America, the best of which were devised if not made in England, we next sent a shipbuilder to France or Russia, to see the application of English steel to foreign ships, or worse still if, from the extent of the damage we receive in war from foes, we first learn the value of the safety offered us during peace by friends. I am perfectly aware of the great difficulty, not to say impossibility, of official examination of all these inventions. Not only do officials often feel for want of time utterly unable to attend to them, but often if the time were given, the subject is one which, being purely technical, they would wisely decline to decide on. If not to scientific institutions supported by Government, there is no other reference possible, and I believe that some day reference will be made as a matter of business to the scientific bodies on all inventions and proposals which seem to promise well—in each case to that body whose special knowledge entitles them to pronounce *ex cathedrâ* on that particular scheme. A favourable report from men above suspicion would entitle the inventor to further trial, and would be the best guarantee for Government against that Parliamentary scarifying which all parties are so anxious to avoid, and if the report were against the inventor, would justify the neglect of the invention so far as Government were concerned. Men will say that this is already done in a different way by the appointment of Select Committees, Royal Commissions, &c., &c. True, if politics had not sometimes more to do with such appointments than science. True, if the jury were always devoid of personal interest in the question. Be this as it may, in some way or other all that is good, as well as new, should be encouraged, not repressed; protected, not robbed.

I should be doing an injustice to a friend and brother officer who has striven, I hope successfully, I am sure most ably, to conquer a lasting reputation on the question of armour and the protection it should offer to life in combat, did I omit to speak of Captain Coles' cupola-ships in my paper? He has been good enough lately to forward me a pamphlet, in which he conclusively shows that many of the objections which apply to the American form of turret do not attach

to his cupolas, and I have no doubt that where the twin-screws are not used, or cannot be used, as the means of turning, his cupolas offer great facilities for the mounting and management of very heavy guns; and while on this subject I will try to overturn a nonsensical, though popular idea, that there ever has been, or will be, a gun made which cannot be carried in a gunboat with the greatest facility as a pivot-gun. The proportionate weight is nothing, witness the long 32 in a Swedish row-boat, particularly if hydraulic or other power be applied to raise it from the hold, when loaded, and about to be fired, which may easily be done, and to a plan for doing which I hear that another naval officer is turning his attention at Liverpool. If this be accomplished, an armoured "close quarters," as our ancestors named them, may be constructed round the gun below, in which in action the crew may be assembled, and whence the gun may be raised, pointed, and fired without the exposure of a single man. Here no armour casing outside the whole ship would be needed, a weak point with the present cupola system, provided the vessel be rendered unsinkable by the means I have pointed out, nor will any damage to the walls of the close quarters, which may possibly occur, be visible to the attacking vessel, so as to enable her to repeat the dose on that particular spot. I think that if the crew at their guns, the vital parts, engines, &c., be protected, very little is needed for the rest of the hull above water, and it is on this principle alone that armoured ships of moderate size can be constructed to fulfil the desideratum of great speed, which is, as I have previously said, of the first necessity; but as I doubt the truth of the conclusions which have been drawn that there will be no more yard-arm fighting or boarding, it will not do, I think, to confine the crew to a box, out of which there is only one upward issue, except through the ports, as is the case in the "Enterprise," and in which, if she is ever boarded, the crew may be stifled or otherwise destroyed, like rats in a hole, before they can get out. So much has already been said against the policy of having very large ships to carry very few guns that I need not here repeat those objections, but I should like to hear how a very serious difficulty is to be overcome when we have such guns in such ships, and which arises from the fact that when heeling or rolling the real gunwale of the ship is interposed between the gun and its object. As all naval officers are aware, though perhaps not all naval constructors or artillerists remember, if your ship heels 6°, and the object is at point-blank distance, the weather guns must be depressed 6°, and the lee guns elevated 6° before they can be laid horizontal, and whatever further elevation is due to a greater distance of target is taken from the weather depression or added to the lee elevation. Now, in such a case I do not see how the weather guns of a cupola ship can be fired at all without shooting away the side of their own ship, or else having an undue elevation and so going over the object. Again, take the case of rolling motion. At the top of the inclination to port the starboard guns have lost sight of the horizon by the interposition of the gunwale; the contrary occurs with the roll or inclination to starboard. This is very unfavourable to accurate aim,

and I am afraid it would be undesirable to raise the weight of the cupola so high as not to produce these effects.

But if we have succeeded in building a man-of-war at last, which has high and lasting speed, with great manœuvring power, which is in a considerable degree unsinkable, and which offers the greatest attainable safety to life in combat, there is only the more reason why we should take every possible means to make so perfect a structure as durable, as science, skill, and attention, can make anything put together by man. Therefore, we will proceed to consider the causes of decay and disintegration, the causes which lessen durability; among these, electricity, which in some measure accompanies or causes almost every change which is undergone by bodies, either organic or inorganic, comes first, and is of the highest importance; I have very little doubt that the hole in the "Harbinger's" pump-well, which the jury in that trial were so anxious should be accounted for, was caused by an electric current, added to, and perhaps in some measure caused by, the vibratory movement of the sounding-rod. That vibratory movement under certain circumstances of inclination in the magnetic meridian of the sounding-rod would be sufficient to make a magnet of it—an electric current caused by the bilge-water—the plate and the iron rod would be set up, and as fast as oxide was formed at the point of contact of the metals, it would be broken away by the tapping, and a hole would soon be formed. Some here may doubt how far a current of electricity can be formed between two pieces of apparently similar metal, but it is now well known, not only that the same rod or wire, heated at one end and cooled at the other, will generate an electric current; but that, commercially speaking, no metal is ever made so perfectly homogeneous, as not to afford such currents, by immersions of separate portions of it in weak acids and water. Here is a battery cell, in which the copper and zinc of the ordinary galvanic arrangement, is replaced by two pieces of iron, cut from the same bar: you will see that the needle of the galvanometer, a delicate suspension one by Messrs. Elliott, is moved at the instant of making contact, and though I cannot here show you the enormous quantity battery which would be afforded by the large surface of a ship's bottom, and have, therefore, been obliged to use acidulated water, instead of bilge or salt water, yet the lesson conveyed remains the same. The bilge-water, there is no doubt, contains several acids, principally of course muriatic and sulphuric, this latter gives evidence of its presence by the evolution of the disagreeably smelling sulphuretted hydrogen gas, and under these circumstances, a galvanic current, of great quantity but low tension is constantly going on. A very common instance of the decay of iron from galvanic action is to be found in iron railings by the water side which have been let into the stone pavement, and secured there by lead cast into the socket. You will find that it does not take many years to eat through a cubic inch of the iron under these circumstances, and I attribute the dropping out of iron rivets in ship's bottoms almost entirely to galvanic action, not to any attrition, which would act as much on the surface of the plates did it exist, and would be shown at the sides of the rivet-

heads, not by general decay of the whole head. The injurious galvanic action might be entirely prevented by coating the bottom inside with a common insulator, such as pitch or asphalte, and if done this would probably add many years to the duration of all iron ships. If steel be eventually used, this precaution becomes still more necessary, for the metal will be originally thinner, and can the less afford any such decay. I think we may safely say that if the galvanic action be impeded or stopped, if that were possible, there is no other cause of decay properly so called, and there remains disintegration, which is now likely rapidly to take place, from the vibration set up in our modern ships by enormous screws, improperly located. Here again the double screw offers advantages by no means to be neglected. The weights are diminished, the vibration is materially lessened, and one screw and engine will often do the duty required, while the other and its boiler is undergoing the cleaning, without constant attention to which there is great loss of power. Besides one screw and engine of 100 horse-power will often give a better effect than the half-power of a single screw with a 200-horse power engine, particularly in aiding the sails as an auxiliary. Thus then there is a cause of disintegration and loss, eliminated by the same means which accomplishes other important results in manœuvring and speed. I will now close my paper by thanking you for the patient hearing you have given me, and trust that discussion on the points I have raised will make the little which I have been able to say upon them more valuable than it could otherwise have been to the members of this Institution, and the rest of the public who take an interest in this important question.

Before sitting down I should like to make a few further remarks on some of the subjects shortly brought before you in my paper. In the diagram (Plate VIII) you will see that the ships building or to be built vary in every possible way; that some vessels carry 18 inches of wood, and some 9 inches; that we do not appear to know what relative proportion of strength is given by the wood and the armour plating,—how many inches, that is, of wood, represent how many inches of iron.

You have here what they all carry. Here is the "Bellerophon," with 6 inches of armour, but unfortunately there is in her much less wood backing than in many others, and we have learned that there is a certain value to be attached to thickness of wood, greater than that which was supposed when they were constructed; but it is a very lamentable thing that there does not seem to be any effort making to stop the construction of that which we all acknowledge to be an error. I know that several of these are still on the stocks, and probably a little pressure brought to bear in the right direction might give us something in the shape of a ship's side which we could rely upon, instead of putting these in the water as they are, and then calling them errors and mistakes.

In explanation of what I have said as to guns placed in cupolas, you have here the model of Captain Coles' cupolas, and the way in which they are placed. You see at once, so long as the vessel is on an even keel, it is perfectly true that you may fire your gun with five or six degrees' depression. So long as the ship is upright, the gun will

depress, say six degrees, and it will strike the water, Captain Coles claims, and I believe quite correctly, as near as could be done with guns on the broadside, if the ports remain as at present. But there is this remarkable difference, that directly that level alters, and the heel becomes greater than six degrees, then, in the cupola ship, you have the ship's side interposed between the gunner and the horizon, and there is no possibility of firing at all. That occurs whenever the ship rolls; it occurs also when she heels over, and your weather guns, if you are attacked on the windward side, are subject to an incapacity of firing when the ship heels more than six degrees, and to a great difficulty in firing when she rolls, for I need not tell any artillerist that at the top of the rolling motion, which is the time chosen generally to fire, the line of sight is here totally impeded. Still more does this apply if we consider the cupola guns as firing with the ship pitching; for then you have got your ship possibly pitching, as I have often seen them at sea, with fifty feet of their bow out of water. Now, how are you to fire your gun? You must wait till you can catch her just half-way between the downward pitch and the upward one; and it would be, in fact, very like putting men at a loop-hole to shoot partridges going past in full flight.

Referring to the diagram of the boiler, you will see that there are concentric vertical tubes placed about the other vertical tubes coming from the fire, which communicate with the outer air by the chimney. Between these tubes there are studs which support the outer ones. I am not aware by whom this has been proposed, but I believe it is now used in Shand and Mason's fire-engines. Under these circumstances, the heated water being confined close to the tube through which the fire passes, it ascends and is constantly replaced by the cooler water descending from above, and passing in at the bottom, thus causing a thorough interchange of the water in the boiler, and probably preventing, in great measure, any tendency to prime.

In the tubes as they exist in one of the ordinary tubular boilers, although it is possible to force a chisel down between them vertically, and thereby to remove incrustation, it is utterly impossible to get a chisel between them horizontally. It has repeatedly come under my observation that those surfaces become connected by a solid wall of lime incrustation, carbonate of lime. The result is that these upper sides of the tubes which ought to be the most valuable part of the heating surface are rendered entirely nugatory.

Referring to the prism, on which I touched in the course of my lecture, you will see at once by sliding it on to the back sight of the rifle, you get the ray of light coming from the object deflected to the eye, without the necessity of raising the cheek from the butt, or lowering the butt under the arm. It is evident that precisely the same means may be used to give a power of seeing without being seen from the interior of the turret ships or cupola vessels, such as we have not yet acquired, and the absence of which is very much lamented by the American officers in their late reports on the subject.

Again, to revert to the main portion of my paper, it is utterly insufficient to armour plate, as if vessels were going to remain constantly on an

even keel. That is a mistake which unfortunately has been made to a very great extent, and which makes every seaman say, the instant those vessels get to sea, they have a weak part like the alligator, which you may attack, and without wasting shot on a defended part. It is not sufficient to put a skin inside, divided into cells, or to have a few great divisions in the bottom. We must modify our whole structure, and make as much of it as possible—a congeries of cells, into any one of which not more than 20 tons of water can enter, and these must be highest towards the side, or "in the wings," that is to say, they must come into the planes of inclination.

I will now ask you to allow me to show you an experiment, which conclusively establishes the fact of the galvanic current existing. I have here two pieces of iron cut from the same bar. Some people will say, "Oh, the ship's bottom is entirely of iron, we do not propose to use copper, and the quantity of brass and copper which is inside is not absolutely connected with the ship's bottom, therefore we shall have no galvanic action." I have watched with great attention sundry processes which have proved to me that there is galvanic action, and having been forced to study electricity from another pursuit of mine in the telegraphic world, I have striven to apply the knowledge so acquired to the solution of questions which have occurred to me in my profession as a seaman. I have got here, I must tell you, sulphuric acid and water, because, as it is utterly impossible for me to give you the extended bottom surface of a ship, I cannot show you in any other way the quantity of the current which would be obtainable from a ship's bottom, and which exerts a most important influence. If you look at that needle in the delicate galvanometer before you, you will see the instant I make contact, it is deflected. That shows a current passing. It is one of those delicate galvanometers constructed by Mr. Becker, of the firm of Elliott Brothers, which are so beautiful in their results; and this, I will tell you, is so delicate that the mere contact of two pieces of copper out of the same wire would produce an effect, there being no one metal so thoroughly homogeneous, no two metals so thoroughly similar, that a galvanic current does not pass between them. More than that, I may say, no two woods exist, which, subject to certain conditions, do not give you a galvanic current between them. We have got the evidence before us, without going into the question of how far rivets differ from iron plates, and they do materially differ, that there is a galvanic current constantly going on between them; and the rivets do drop out, not because of the attrition of the coal-dust, but because the coal-dust liberates sulphuric acid, or the wood employed as backing liberates other acids, which, mixed with the bilge-water, evidence their presence by the evolution of sulphuretted hydrogen, a gas which mainly contributes to give the peculiarly disagreeable smell to bilge-water; and that bilge-water is capable of setting up a current, whose effects are sometimes evinced in iron ships, by the dropping out of the rivets at the bottom. Lloyd's surveyor mentions one case in which over 1,000 rivets thus dropped out, and another in which half the plates were decayed in the bottom.

I intended to have prepared wrought-iron, cast-iron, steel, rivets, and so forth; but I have shown you, and there can be no more conclusive experiment than this, two pieces cut from the same bar; therefore, I have not thought it necessary to go into the other experiments. I think you will acknowledge, the lesson conveyed remains the same, although I cannot here show you the enormous quantity due to electric action on the whole of the ship's bottom.

The rivets run in lines, mostly in vertical lines up the inside of the ship, and parallel to each other; of course there are the butts which join across, but you have a number of parallel lines; now, you do not find, as would be the case were it due to attrition, that the sides of the rivet-heads are eaten away, and the other parts left protected, as they would be against the attrition by the next rivet to them; but you do find that the whole rivet-head goes, and the rivet drops out.

The CHAIRMAN said, they would agree with him in returning thanks to Captain Selwyn for the very interesting paper he had read, and for the several very ingenious considerations which he had brought forward, he believed for the first time. He should be happy to hear any gentleman who wished to make any observations on the paper.

Rear-Admiral HALSTED: I may be permitted to make one remark upon Captain Selwyn's proposition, which, if I have understood it right, may go forward, if unexplained, I won't say uncontradicted, and create a great deal of misapprehension in the service upon a point which is very important. I mean where he refers so confidently to the experiments now being made, and lately made at Portsmouth, with spherical steel shot out of the new smooth-bore gun proposed by somebody or other; but it appears that the paternity of it has been adopted by the Admiralty, and has been so referred to by Lord Clarence Paget, Secretary to the Admiralty. One cannot help remarking on that importance which is placed upon these experiments at Portsmouth, not only by the Secretary to the Admiralty on bringing forward, the other day, his navy estimates, but also previously, upon the 9th of this month by the First Lord of the Admiralty, his Grace the Duke of Somerset. They both point out the great value of the supposed invention, and of the increased power of firing the steel round shot out of a smooth-bore gun directed at certain target-ships at Portsmouth. The target-ships selected for these experiments have, unfortunately, been such that it is not possible that any serious consideration can be given to them. Everybody is disposed to give all due credit to an old servant, but that old servant by no means represents the resistance which would be found in absolutely new constructions built for the express purpose of resisting the guns, intended to penetrate the armour-plates now being employed in every navy. I do not think we shall find a single ironclad afloat and built, furnished with her equipment of armour for a longer period than six years. Yet what are the ships which are being selected, and which have been selected for many of these experiments, and for exhibiting that resistance which we shall have to meet in the case of newly constructed ships? I take, in the first instance, that of the "Monarch," built in 1832, and which, therefore, is now 32 years old. I take for the second case—the "America." By good luck she exists nowhere, because she was sunk the other day at the last experiment; but she was built in 1810, and is, therefore, 54 years old. Now, the steel shot for the first time have been sent down to Portsmouth to be fired out of this new smooth-bore 100-pounder gun, whereof so much has been said, and to which so much reference has been made by Captain Selwyn.

Captain SELWYN: I referred also to the old 68-pounder fired in conjunction with it.

Admiral HALSTED: Never until the other day; for the first time on Thursday.

Captain SELWYN: On Wednesday and Thursday last.

Admiral HALSTED: Not upon Wednesday, but upon Thursday only; the first time

it has been done with the 68-pounder. In regard to firing upon the "Monarch," the facts of importance are simply these: The "Monarch," with a 5½-inch plate upon her side, represents an absolute substance at the lower port sill, which is taken as the standard, of 32 inches in thickness, divided between 5½ inches of plate and 26½ inches of the scantling of the ship. Certain steel shot were fired at her upon the 14th of January. When I say the 14th of January, I take my statement from the account which appeared in the *Times* on that day; and of the four steel shot which were then fired, the two first Nos. 1 and 2, struck the edge of the plate, as it is described, and both of them went right through the whole 32 inches, including the 5½ inches armour plating. The third shot stuck with its outer surface two inches only below the outer surface of the armour-plate, and the fourth shot also stuck, whether deeper in, or less deep in, is not stated in the account from which I quote. But nothing can well be more contradictory, or self-contradictory as it were, than the circumstances which I have now adduced, wherein out of four shots fired from the same gun, at the same time, with the same charge of powder, and the same weight and nature of shot, and at the same place, one consecutively after the other, two of them go right through everything, passing the 32 inches of resistance, while the next two of which, of the first only the measure is given to us, enters only 11½ inches altogether, that is to say, about 2½ inches below or within the armour itself, and the 9-inch diameter of shot together; therefore, there was, in that case, 20 inches of penetration yet to be made, or nearly double that which had been made. I have said that no measurement has been given us of the fourth shot, but the description given is similar to that of the third. Now, when we come to the older ship (the "America") we find very nearly the same thing. We find, first of all, a shot which goes through everything—I may correct myself—it goes through everything except 2½ inches. In the case of the "America," I should state, the whole combined construction presented a resistance of 29 inches, three inches less than that of the "Monarch." Then, as I have said, the first goes through 26½ inches only out of these 29 inches, the next goes through 12 inches altogether, that is to say, it stops and is stuck, as the expression is, after it has penetrated but 3 inches below the outer surface of the plate; therefore, before that second shot there is 17 inches yet to be penetrated. The third gun goes through everything again. Now, I ask which of these penetrations is to be considered as the true measure of resistance of the "Monarch" and of the "America?" In order not to be too long, I will take the "America," the last ship fired at. Is it to be the 11 inches or the 12 inches, which left 17 inches or 18 inches still for penetration, or is it the shot that goes through and through all? As I have said before, it being in each case the same gun, with the same charge, the same steel shot, from the same distance, and at the same plate.

Admiral Sir GEORGE SARTORIOUS: It has got an additional knee or something of that sort.

Admiral HALSTED: All ships have knees of some sort or another that I have ever sailed in; and I am afraid when shot come in they will have to meet with knees occasionally. But here are circumstances of such absolute self-contradiction, it being in all cases perfectly sure that the gun presents no variations; but I do not think it is possible for any person to see how the variations can be attributed to any other cause or reason than that of the variable circumstances of a sound part or of an unsound part, whether in the plates, whether in the ship, or whether in both. I have now spoken of the experiments which occurred on the 4th and 24th of January. Last Thursday there were similar experiments, and what did they prove again? They were both tried on the "America." I will only take two instances, the two particular steel shot which were fired again out of the 100-pounder smooth-bore gun, and also at the same distance, with the same charge, and at the same plate. I will take the case of the 5½-inch plate then fired at, because 5½-inch plates were fired at also before in the "Monarch," and on the previous occasion on the "America." Now, those shots did not even penetrate the plate; they did not lodge, or if they lodged, they lodged only sufficiently that when the second shot struck it knocked out the first. Upon both those occasions there was a projection—I won't tax my memory to the fractional part of an inch, but the shot absolutely projected in both cases beyond the outside, or outer surface of the plate, to the extent, I believe, of more than two

inches; but it is merely a question of memory, which may be incorrect. Now, this is the case again with the "America," the same ship. What I ask is this: the "America" is 50 years old we will say; will any gentleman suppose that that ship has increased her strength since she was built, or we will say from the time she was six years old until the present day? Am I wrong in concluding and asserting that necessarily that ship is weaker now than she was on the first day she was built, or the first six years that she was built? and that her resistance is now absolutely less than it could possibly have been when she was a new ship? When we take this measurement, and when we look to any of these variations in the experiments—in one case the shot going right through and through, and in the other experiment of the shot sticking; it had not even buried itself, and was two inches outside. Which of these two circumstances represent the true resistance of the "America?" Undoubtedly reason tells us that the true resistance of the ship is represented by the shot which penetrated least; and even with that amount of concession, is that the amount of resistance that that ship would have presented at sea as a new ship, or as one merely six years old? Is that a resistance at all to be compared with that which British guns will have to meet when they come to fire against and to contend with armour ships, not one of which, instead of being 50 years old, will be much more than five? Now, the thing I protest against in these experiments more than another is that performances made by any gun, I do not care what the gun is, under circumstances where it is not possible for the resistance to be represented with any truth whatever, compared with the resistance which those guns will eventually have to fight against as when brought against true armour-ships; that that should be put forth to the public as the power of these guns, and that those guns should be pressed upon the navy as enabling us to fire through and through a French armour-ship, for instance, as they have fired through and through the old "America." I think it is necessary to make such a protest against the position of my friend, which will go forth to our Service that such and such is to be the measure—that the measure of the penetration through and through the "America," is to be the measure of the power of the gun which he proposes we should all have to fight an armour ship with.

Captain SELWYN: Pardon me, I particularly stated that it was to be taken as only a comparative experiment.

The CHAIRMAN: I would suggest that it would be better for you to reserve your reply to the last, except it should be a particularly short explanation which you might wish to give of some mistake that may have been made.

Captain SELWYN: Admiral Halsted is arguing against what I did not state. I only wish to say that I particularly guarded myself against saying, or being supposed to say, that these were anything but comparative results.

Mr. VICKERS: I fear that I have no very important information to give. I have a feeling that cast steel will not do for armour plates as they are at present used. The reason for my opinion is that I have made experiments very much of the character that Captain Selwyn says ought to have been made; but instead of using a steam hammer, I have used a more easily measurable test, viz., a ram of 14 cwt., dropping it upon bars of steel placed upon bearings 3 ft. apart, from heights of from 1 ft. to 40 ft., which, of course, give considerable velocity to the blow. Under this test I found that soft steel would resist far more concussion than any wrought iron, and from that I was led to the conclusion that steel was the best material for armour plates, until the trial at Antwerp of cast steel armour plates of Mr. Krupp's manufacture. I dare say many here will know the results better than I do. I simply know that the plates cracked. It at once struck me that his plates were made too hard and brittle, containing too much carbon; but I succeeded in obtaining a small piece of the material, and from a very accurate test I made of its hardness, I found that it was very soft, and that judging by my trials, it ought to have stood the test if steel would do. Any increased softness would not have given additional toughness, and from Mr. Krupp's great experience as a steel manufacturer, I have no doubt that the plates were of as good steel as they could possibly be made. I have come to the conclusion that steel will not do on account of its great elasticity, the blow, when given with such great velocity as that of a cannon ball, being communicated too quickly through the mass, and causing a fracture, while softer material yields at once at the point struck, and

the injury is local. If something could be put in front of the steel so as gradually to take up the blow, that I should say would be the best mode of enabling a plate to resist the shot. Whether such a thing is practicable or not I am not prepared to say. If any other questions should be asked on the subject, I shall be very glad to give an answer.

Sir GEORGE SARTORIOUS: Would a plate of wrought iron outside the steel produce that effect?

Mr. VICKERS: I should think wrought iron outside would hardly be soft enough. It must be something softer than wrought iron. I am not prepared to say exactly what.

Captain HARRISON, R.A., Secretary Iron Plate Committee: There are one or two remarks I should like to make, first with regard to what Mr. Vickers has just stated. Captain Selwyn alluded in the paper which he has read this evening, to the steel not having been used more in ships. I think that what Mr. Vickers has said upon the subject is a very ample answer to that question, viz., the uncertainty of Bessemer's metal. Although it is extremely valuable, yet there is such uncertainty in it that it is not safe to rely upon it altogether for ship-building. Hitherto, although I have no doubt the difficulty will be, and is being, rapidly overcome, I think the reason I have given is a fair one for not using Bessemer's metal for building ships. I am referring to that letter of Mr. Bessemer's which I have no doubt you have all read in the "Times;" and exactly the same thing holds good with respect to what Mr. Vickers has said about steel for armour plates, viz., that it is not reliable, and you cannot use it for armour-plating. In the very earliest experiments made by the Iron Plate Committee to test steel and wrought iron, it was found, that the steel armour-plates sent to them to be tested, up to three-quarters of an inch were far superior to the wrought-iron plates; but the very moment you got beyond three-quarters up to an inch, the plate cracked at the very first shot, and was useless. The gentlemen who supplied those plates to us from Sheffield, eventually gave up sending them. They said they were perfectly satisfied that they could not be used. In all the experiments which have been made from that time up to this, with steel plates sent of various thicknesses, whether to Portsmouth or Shoeburyness, there has always been the same result. We have had steel plates from Sweden sent with very great confidence on the part of the gentlemen who supplied them. They have been tried at Shoeburyness, and at the very first shot away they went, cracking like a pane of glass. Certainly, at the present day there is no doubt that steel will not do for armour-plating. The suggestions that Mr. Vickers made about placing something in front of the armour-plate, would be very good probably, if it was not for that very awkward customer, the shell. But the effect of it is, as we have tried at Shoeburyness, when you face your armour-plates, as has been proposed repeatedly; and is proposed now, by putting projecting substances in front of them, such as layers of wood, alternate plates, and so on, so as to reduce the shock on the armour-plate, the very moment the facing is penetrated with the shell, the shell explodes and blows it away, and your armour-plate at once becomes exposed. Therefore, although it might for a round or two save your plate, it would be but a temporary good. Admiral Halsted made a rather severe attack upon certain experiments that we have read of in the papers, but I think he misconceives the object of those experiments.

Admiral HALSTED: The fact or the object?

Captain HARRISON: The intention of those experiments.

Admiral HALSTED: I thought you said I made a mistake in the fact.

Captain HARRISON: No; not the fact. The experiments, so far as I understand them, and I have seen a good many of them at Portsmouth, are not to test the resistance either of the "America" or "Monarch," as to their power of resistance, in the same way that the "Warrior" target is put up and tested at Shoeburyness, or the "Bellerophon," or any other target. It is not to test the resistance of these ships; it is to test the quality of the armour-plates which are supplied, and also the quality of the steel shot. Admiral Halsted asked how it was that certain steel shot went through 5½-inch plate, penetrated the ship's side, and went out at the other side, whilst another shot fired from the same gun with the same charge of powder, simply stuck in the plate, and projected 2 inches. The simple answer to that is this,

that one shot fired from that gun was a shot probably made of Firth's steel, an extremely expensive shot, or was made by the Elswick Ordnance Company, or at some other place, of extremely expensive steel, whereas the shot which squeezed up and stuck in the plate was a shot made perhaps of Bessemers' metal, costing instead, of £50 or £60 a ton, only £18 or £20 a ton; therefore, it does not do as much work as the very much more expensive tooled steel shot. The object of those experiments, as I said before, was not to see what the "America" ship would keep out, but to obtain as soon as possible steel shot of a serviceable quality, and at a cheap rate. We all know that there have been ample experiments made which prove, that if you choose to pay money enough, you can penetrate the "Warrior," or any of those other ships. But the object is now with the experiments that are being carried on to endeavour to get a cheaper steel to do as much work as we can. I may state what result has been obtained at Portsmouth from giving a little attention to the improvement of cast iron. Whereas with the ordinary service cast-iron shot which was fired at a plate, an indentation was merely got of a little over 2 inches, by using cast-iron of the manufacture made in the laboratory, an indentation was got of over 7 inches. I, therefore, think that the experiments which have been carried on, although they may not enable us to see what you gain in resistance as regards the ship, they do give very valuable information respecting the improvement of our projectiles. There is only one more point upon which I should like to make a remark. Captain Selwyn remarked upon the great desirability, whatever else we did, of keeping out shell. We all know the old exclamation which has been heard over and over again, "For God's sake keep out the shell." Certainly in the present day that becomes almost a work of supererogation. I dare say most gentlemen have seen a picture in the "Illustrated News" of an experiment with the 600-pounder which I was fortunate to see myself at Shoeburyness. I certainly think when we get a 600-pounder which can be fired accurately, and penetrate a "Warrior" target, as it did down there at 970 yards' range, the bursting charge of the shell being 29 lbs., I do think it becomes very hard work to keep out a shell of that power, more particularly when this shell is of steel. I may say at the same time that the accuracy of that gun was most remarkable, for at 1,000 yards' range, a wooden target was put just beyond the "Warrior" target, a little to the right of it, in order to get the range and save the steel shell. The first cast-iron shot that was fired to get the range, knocked over the wooden target which was at 1,000 yards distance, and the third shell fired from the "Warrior" target at 970 yards' range, struck the target, and, I may say, absolutely demolished it, because it had been intended to have the target removed to 2,000 yards to try the gun at it, but the target was so completely demolished that it was not worth removing; therefore the experiment could not be tried.

Admiral HALSTED: I do not know whether I am entitled to a word as to what has been said.

The CHAIRMAN: Merely to explain anything.

Admiral HALSTED: It is merely as an explanation. I will only say, I have noticed the experiments made at Portsmouth very carefully, and I would remind my friend Captain Harrison, that the actual proving of the plates has in each case, as stated in the account, preceded the experimental trial, subsequently made with the steel shot, and it will be seen, in proof of that, that in every case the steel spherical shot have been fired upon previously undamaged parts of the plate; so that it is not for the proving of the plates.

Captain HARRISON: I said the proof of the shot; the proof of the plates takes place, in the first instance, and the proof of the shot, which takes place in the second, is to test the quality of the shot, and not the resistance of the ship.

Admiral HALSTED: Very good. Then there are terrible differences, irreconcilable differences, in steel shot.

Sir GEORGE SARTORIOUS: My opinion for some time past has been, that in the contest between the gun and the plate, the gun will have the advantage. What I have just heard from Captain Harrison, I think, is quite conclusive. Of course, every sailor knows that a ship that is bound round with that heavy mass of iron, can never be a lively vessel calculated for ocean navigation. If the 600-pounder is a gun that will stand and will fire shot of that kind, we may save ourselves a great deal of trouble in going into all these investigations about the iron protection for vessels.

What we have to find out now, is that which would be safe for a vessel, and which would make the least resistance for gentlemen of that size, and let us give them every facility to go through; we will pull off our hats to them, and think ourselves very happy if they walk off without doing us any mischief; but as for adopting any kind of protective means against shot of that size it is useless; and I trust the Government will go on, and by every possible means encourage the manufacture of guns of that size, and let us for the present lay upon our oars, without building any more of those vessels. If we go on with these guns, and if the American guns are capable of going through our armour-plates, then, of course, common sense points out that it is utterly useless to go on increasing the thickness of the plates, because, under the most favourable circumstances, armour-plated vessels can never be ocean cruising vessels; they will never be fit for it, although they may do a great deal of service under favourable circumstances. As long as you could make the ship invulnerable to shot, it was an enormous advantage, but take away invulnerability from the ship, and the armoured ship sinks to a very low comparison indeed with the old wooden ship. All we have to look to, is to endeavour to make ships uninflammable, put these large guns on board, and then we must endeavour to find out the forms that will be the most convenient to carry them.

Major-General Boileau, F.R.S.: I wish to ask one question of Captain Harrison. I want to know whether in the experiment tried last Thursday at Portsmouth, with the ordinary cast-iron, or with the crucible cast-iron, or with Price's patent cast-iron shot—they did not all break up after they struck the ship's side?

Captain Harrison: There were two of them fired from the 100-pounder smooth-bore; one fell into the sea, and we could not tell what state it was in; but the laboratory shot remained in the plate, about three-quarters of it was in; we took it out of the plate, and found about three-quarters of the shot intact sticking in the plate.

General Boileau: The fact is, then, that a cast-iron shot has been produced which has passed through an armour-plate without breaking.

Captain Harrison: It did not pass through; it drove pieces of plate in front of it. When the shot was taken out, the depth that it had penetrated into the side of the ship, was just over six inches.

General Boileau: That is more than the thickness of the plate.

Captain Harrison: That is more.

General Boileau: The plate was pierced through, and the shot was not broken; that is a great step gained.

Captain E. G. Fishbourne, R.N., C.B.: I have to complain of the experiments, not in the same direction as Admiral Halsted, but just in the very reverse. He is asking for explanation of various circumstances that have been alluded to by Captain Harrison. They may be multiplied amazingly; the difference of strength of powder varies 20 per cent., and the difference of the effect of the shot, as a consequence will at once account for the alleged discrepancies. Then there is the circumstance of the striking on the edge of the plate, for unfortunately you cannot have ships clothed without having edges to the plates; and so you must accept it as a fact, that if the shot goes through the edge of the plates, when they are on the ship's sides, the ship is rendered as sinkable as if the shot had gone through the centre of the plate. But what I complain of is this, that we are continuing a series of experiments, costing a great deal of money, that will have to be gone over again when we get guns strong enough to bear sufficient charges. I want to know why the old 68-pounder, 112 cwt. gun, has not been fired with its ordinary charge? As I have said before, and as has been repeated to-night, it has been "how not to penetrate plates." We have been using small charges, in order to accommodate those small charges to the bad guns previously made, and which were to be palmed on the public That is the history of the matter; and so now they say one-quarter the weight of shot is the proper charge. Will any enemy say:—"The English people are firing charges of only a quarter of the weight of the shot, we must be transcendental like them, we also must be scientific, and bring our charges down to one-fourth." Why should we continue to act as if we believed such nonsense? Why go on in this way? The problem is, that there are certain plates to be pierced; we should for this burn as effective, and as much powder as the gun will bear, for that purpose, and it is useless to make experiments with small charges and bad powder.

The French 30-pounder, that is the counterpart of our old 32-pounder, burns 35 lbs. of powder, and we are firing our 68-pounder with 16 lbs. of powder. What is the result? Why, they penetrate 5½-inches of plate at 1,097 yards with shot three diameters long, and which will admit a very large bursting charge. You have only to improve our 68-pounder, and you can imagine what will be the result. I must differ from Sir George Sartorious, when he suggests the propriety of making more 600-pounder guns, that in all probability won't last. Either they expand in the bore, or the shot jambs after the sixth round. There was a great fuss about the shot having gone through 4½-inches of plate, though the gun cost £3,800, when the French gun, only a 30-pounder, costing, say, £100, sent its shot through 5½ at 1,097 yards. I protest against these experiments, and say that we ought not to be having experiments of this half-and-half kind. The problem, as I said before, is to penetrate the ship sides with the smallest gun, whatever thickness of plate, whether 5, 6, 7, or 8 inches. The result of which would be, that you could have cheaper guns, and a greater number of them. I am not an advocate for small guns, and never was; but there is a medium gun, the size of which you cannot exceed without disadvantages. I quite concur with Captain Selwyn, that the time has come when we must give up the idea of having plated ships as *the rule*. The plates are great incumbrances; they involve a reduction of speed, a reduction of guns, and a reduction of every good quality. I am satisfied that the ships will be very bad sea-boats, I mean to say they will be comparatively bad men-of-war. You won't be able to fire with any degree of accuracy; so while you are reducing the number of your guns in one direction, you doubly reduce them, because you reduce their effectiveness. I think there ought to be experiments to ascertain what they are really worth. I do not think myself that, as vessels for guns, they are worth much; and I think for the purpose of experiment you can fairly judge them, not absolutely, as Admiral Halsted wants, yet we can satisfactorily measure what thickness of plates will be penetrated, when we get a gun which will give a sufficiently high initial velocity.

Rear-Admiral Sir Edward Belcher, C.B.: I have very few words to say upon the subject, and I do not know whether it would be fair to go on with this discussion, because I really think it is not on Capt. Selwyn's paper. But we have one thing to consider, viz., that we have many wooden ships abroad, and we have many officers commanding them who would have to meet these armour ships. I think the question, as Admiral Sir George Sartorious has suggested, is how are we to fight with the ships that we already have? I am perfectly satisfied that there are many officers in the service who would have no hesitation in one of these wooden ships, if she had speed, in making a very good fight with the armour vessels; and I am perfectly satisfied that one of these vessels well handled would, even with her weight of wood, walk over one of these iron ships, and put her under water.

The Chairman: If no other gentleman wishes to make any observations, I would invite Captain Selwyn to say anything he likes in reply.

Captain Selwyn: I had hoped to have heard some observations from the authorities present confirmatory of the facts I have advanced, as I did not fight the gun question so much as the question of decay; and with respect to that I have not heard any observations at present.

The Chairman: I would only say with regard to your electric experiments, that the actual question of the corrosion of the metal would be more satisfactory than experiments made with such delicate instruments as these. It is quite true you cannot take any two parts of the same bar without getting a deflection, if you use so delicate an instrument as that. An experiment showing the actual corrosion taking place would be more satisfactory.

Mr. Reynolds: If a very slight interruption is not out of place, perhaps it may not be uninteresting to mention I have just seen the "Rainbow" steamer lying at London bridge. This is the first iron steam-vessel that was built, between 20 and 30 years ago. She is now in good order; and I, therefore, think that is the best answer to the theory respecting galvanic action.

Captain Selwyn: If you please I will take the speakers in order as they occur. Admiral Halsted made a very strong fight for a stronger target.

Admiral Halsted: For a true target.

Captain SELWYN: I did not say by any means that these were results on which we could depend in combating with such iron-clads as those in the diagram before me. I said merely that a man seeing that those experiments had been made, and had produced the results which we have here in our table, seeing that those experiments have been made with such bad guns, and with such bad powder, and such bad shot, I would say there was a probability of good guns, good powder, and good shot being made which would do as much as we have got to do. I said that they could be made, because I know that the metal at our disposal—I do not say the armour-plates at present—but the metal at our disposal has been efficiently used in guns, and can be still further developed. That steel, as it bears a tensile strain of 63 tons to the square inch as against 25 tons, is better worth trying than a metal which never could have given you more than 25 tons; for if it could have done so, I think the experiments on which we spent so much money might have proved it. That metal, I must observe, has not been recently placed at our disposal. We have not been offered steel now for the first time; it has not now been brought forward as a material for shot. We might have had it three years ago just as well as at this day; and we certainly ought to have tried, if we lay claim to being scientific men, the experiments first with the best material, not with the worst. I speak principally of steel as affording a means of diminishing bulk and increasing strength in the bow and the bottoms of ships. Now, it has been tried for ships. It has answered for ships; ships are running, small vessels I admit, but they are now running with the steel in their bottoms; and except certain blistering and other symptoms, which I refer principally to galvanic action, there has been no great complaint of them, other than a degree of elasticity, which made it unpleasant to put a glass of wine on the table. That might easily be conquered by a better arrangement of the construction with a view to that elasticity; and I complained principally, not that we had not steel in its full perfection now, but that nobody had tried whether it could not be brought to its full perfection for this purpose. Nobody knows at this moment whether steel, changeable as it is by the most minute variations of ingredients, by the one per mille of phosphorous, by many other chemical ingredients which escape us in the fumes of the furnace, but which are now being considered at their due value for the first time; it is because such knowledge exists, and has existed for some time past, that I think the experiment ought to have been made in steel and alloys of other metal as much, if not more, than have been made in wrought-iron, cast-iron and other inferior materials. Captain Harrison attacked the question of iron-plates, as if I had been speaking of steel armour-plates. I did not speak of steel armour-plates at all. I spoke of Mr. Bessemer enabling us to carry 9-inch armour-plates by the use of steel in the hull of the ship, which is a totally different thing. I cannot understand what prevented our attention being given to the subject in this way, as I cannot understand why a private individual could conduct experiments which go *gradatim* towards their object, and why the Government could or did not do so. Mr. Vickers, who is well entitled to speak about steel, tells us at once that the very first thing he did was to resort to the experiments which I suggested, though not in a similar form; but I do say that by putting plates of steel and iron with their proper backings under a steel hammer or a drop, you do get a valuable series of experiments, which would not cost much, and which men of business or science would make, and which, if Mr. Babbage or Mr. Gravatt had been on a commission, they would certainly have orced on our attention as mathematicians and engineers. I do complain that these experiments are not made, and that if I wish to seek information as a scientific man, I cannot go and take tables, on the question of resistance to impact, of the different metals and woods, as I could take tables on any other property of these woods and metals. £36,000 a year spent on experiments, and yet we cannot get such tables as these! I have the very greatest respect for Admiral Sartorious' conclusion on almost every point; but I must differ from him in thinking, as he seems to do, that because a ship carries armour, therefore she cannot be an ocean steamer. I think our experiments on the "Warrior" teaches us that although there are certain objections to them, yet that they do make very efficient vessels. We get 14 knots out of the "Warrior," and if she were thoroughly protected, I should not find much fault with her qualities at sea. She rolls badly, but perhaps that is the consequence of stowage

and various other things, which may be corrected; but I do not think it, by any means, an impossibility for a vessel carrying nine inches of armour to do well as a sea-vessel. We have not succeeded yet it is true, but there is a good old principle which I think none of my naval brethren will dissent from, which is, "Try it again." Now, uninflammability is, of course, one of those things which we should all seek to gain, and if obtained by some such compound as Bielefield's, it may meet in a measure the question of outside coating to armour-plates also. I am perfectly certain that by whatever means we may reduce the velocity of the impact which first takes place on the armour-plate, if those means be at all feasible they are worth considering. I know a great deal of attention has been given to that point, yet I think that with a mixture of metals, having different qualities in our plates, we may get a great deal more done than we have yet succeeded in getting. I long ago pointed to the fact that for the measure of penetrative power a lead target, which would not be a very expensive one because a great deal of it would be recoverable and refusable, would be most serviceable—would give a measure of penetration which we have not yet had. I confess I like those scientific results which remain for us, which do not consist in firing shot that cost £50 against a target costing £5,000, and then triumphing over the destruction of both. What Captain Fishbourne has said I so fully agree with, that I will only notice one point of dissension. He does not concur *with me* in doing away with armour-plates; but he concurs with Admiral Sir George Sartorious. Sir Edward Belcher said I was undergoing an attack which, as Admiral Halsted said with respect to the "America," I was not prepared for. On the subject of guns I did not advance many things, only that better guns could be made, therefore I think I may thank him for his remarks. I had prepared a Table (see Appendix), thinking these experiments were of considerable importance, just to refer to, and the extraordinary fact is, that I see some people who were present at the experiments, and who seem to have noted them, and who believe there was no penetration at all. Now, that that should be the case, as you see here with the 4½-inch plate the depth of indent is 7 inches, and yet there should be no penetration, I confess myself utterly unable to conceive.

Captain HARRISON: No penetration of the ship.

Captain SELWYN: We have heard that the plates were on their trial, and not the ship.

Admiral HALSTED: When a man says plate he means necessarily the ship.

Captain SELWYN: There certainly was penetration there, and the gun had a very small mouthfull to do it with. With regard to the question of electricity, and the proof of what I have stated, not being important, I can scarcely admit it. It may be true that in one ship, which has been long in existence, the rivets may not have suffered. There you must seek the occult causes which prevent the usual action of the galvanic current.

Captain FISHBOURNE: There is no proof that the rivets did not suffer.

Captain SELWYN: The gentleman who spoke supposed because he saw a vessel still in existence, one of the oldest iron vessels, that there was no galvanic action to produce corrosion. I am not speaking against iron vessels, but merely that if we make an iron vessel of 6,000 tons, costing half a million of money, it is worth while to look into the causes which may promote or retard their decay, no matter whether it be done for the purpose of a man-of-war, or for the purposes of the Australian line, which we hope to see established by the use of twin-screws. It is a point which must be attended to, and it is of the very first importance, and when it is understood no such results will take place, as were evident in the "Harbinger," without anybody being able to overcome or even account for them. No scientific man—though I can scarcely claim to be a scientific man, yet I hope some day to obtain that position—no scientific man can bear to see a thing going on for which he cannot find the reason; still less can he bear to see an object over which he has spent much time and much thought decay, without the power of arresting such action, because he has failed in his scholarship with nature. I do think, therefore, that the inquiry is of some value, and that it may be profitably further pursued. The case of steel vessels, as I remarked, will bring that more strongly home to us, if we are to use steel with the view of getting lightness of structure and with the view of carrying the weights which we have to carry, then it is worth while to consider how we can arrest the decay, which might otherwise prevent our using so good a material.

TABLE *of Experiments on board Gunnery Ship "Excellent," 24th and 25th February,* 1864.

Nature of Gun.	Number of round.	Charge.	Weight of Shot.	Nature of Shot.	Range.	Thickness of Plate.	Diameter of indent.	Depth of indent.	Remarks.
		lbs.			yards.	inches.	inches.	inches.	
Wednesday, 24th Feb. 68-pounder Smooth Bore ..	..	16	68	Cast iron service..	..	4½–6	..	1½	Shot all broke up.
Thursday, 25th Feb. 100-pounder Smooth Bore. Weight 6 tons, 9 ·22 bore	1	25	100	Laboratory cast-iron	200	Brown 4½	10	6½	Shot destroyed.
" "	2	"	"	Price's Crucible iron	"		"	7	" "
" "	3	"	"	Steel	"	6	..	7·12	Knee started, two planks broken.
" "	4	"	"	Steel	"	Cammell's 5½	..	4·62	
" "	5	"	"	Steel	"	"	..	6·42	
" "	6	"	"	Steel	"	6	..	6·32	
68-pounder Smooth Bore, 95 cwt.	7	16	68	Wrought iron, case hardened	"	Brown's 4½	9	2½	
"	8	"	"	Steel	"	"	8	4½	Stuck in plate.
" "	9	"	"	Steel	"	"	..	4·1	Shook out previous shot.
" "	10	"	"	.. ..	"	"	..	..	Struck lower edge of plate; went right through bottom.

Evening Meeting.

Monday, March 21, 1864.

Lieutenant-Colonel T. ST. LEGER ALCOCK in the Chair.

NAMES of MEMBERS who joined the Institution between the 7th and 21st March:—

Hore, E. G., Captain, R.N. £1.
Talbot-Harvey, W., Major, 1st Middlesex Engineer Volunteers, £1.
Liddel, W. H., Commander, R.N. £1.
Perceval, H. L., Lieutenant, R.N. £1.
Pooley, Henry, Captain, 2nd Cheshire Artillery Volunteers, £1.

THE INFLUENCE OF THE PRESENT KNAPSACK AND ACCOUTREMENTS ON THE HEALTH OF THE INFANTRY SOLDIER.

By W. C. Maclean, Esq., M.D., Deputy Inspector-General, Professor of Military Medicine, Army Medical School, Netley.

Mr. Chairman and Gentlemen,—I purpose this evening to call your attention to the influence of the present knapsack and accoutrements on the health of the infantry soldier.

Whatever may have been the case in times past, it is certain that everything bearing on the health and happiness, the moral, and physical well-being of the soldier, is now a subject of anxious consideration to the authorities, and of interest to the community at large.

After much careful inquiry into barrack and hospital accommodation, including the important subjects of ventilation, drainage, and surface space, very considerable improvements have been carried out, with the results of diminishing sickness and mortality in a very remarkable manner. Increased attention to clothing, food, moral, and intellectual training, and wholesome recreation, has gone hand in hand with the other improvements, and materially contributed to the end in view.

Among the improvements just mentioned, few were more imperatively called for than those affecting clothing. If time and the occasion admitted, it would not be a difficult task to show, that for a

long period of time the inventive genius and good sense of this country were not seen to much advantage in military costume. The "follies of the wise" have often been conspicuous in the clothing and equipment of our soldiers. The generation familiar with heads laboriously soaped, powdered, plastered, and pigtail-tied, has only just passed away. The satirist who sang—

> "God bless the Guards, tho' worsted Gallia scoff;
> "God bless their pigtails, tho' they're now cut off,"

has not long disappeared from the clubs of London.

It is only within the last few years that any difference worth naming, was to be seen in the dress of the British soldier in Calcutta, and one quartered at Chatham.* A very few years ago I saw a batch of unhappy recruits learning their drill at Arcot, the hottest station in the hot Carnatic, buttoned up in red jackets, lined with stout serge, that had been served out to protect them from the cold of the English Channel.

The great bulk of the British army embarked for service in the Crimea, clothed in tight-fitting coats, the skirts of which had been pared away until nothing remained but a ridiculous appendage, fondly imagined by tailors to resemble the tail of a swallow. We still see these garments in Monmouth-street, and on the persons of deputy-lieutenants of counties, on occasions of state. In the museum at Netley, we have a collection of military head-dresses, most wonderful to look at. Yet they were very dear to their contrivers, and—in another sense—to those who had to carry them on their heads in all climates, from Canada to Cawnpore. Most of them, I have no doubt, are familiar to many gallant officers present; they are old acquaintances of my own, for I may truly say I have seen nearly all of them "Dance into light, and die into the shade." We preserve them for the wonder, if not for the admiration, of generations to come. Then we had the leather stock, we all remember it well; how long it stood its ground, how hard it was to get rid of; and I have no doubt that, like myself, some of my audience are acquainted with a few elderly friends who cherish the memory of that garotting apparatus to this day.

Forgive this retrospect at past errors; trivial, ludicrous even as some of them now appear, they were each in their time and degree causes of suffering, sickness, and premature death.

If we have made mistakes, let us not be ashamed to own them, and let careful study teach us to avoid them for the future. On my appointment, three years ago, to the chair of military medicine, in the Army Medical School, I was placed in a position where I could study on a large scale the chief causes which influence the health of the army. As at Fort Pitt formerly, so now at Netley, the invalids from all parts of the world may be said to pass in review before the

* Professor Longmore assures me that the tunics and trowsers issued to his old regiment in Bengal, during the mutiny, were heavier than those worn in Canada.—W.C.M.

medical officers of that great establishment, who have thus an opportunity of examining men who have served in almost every region of the globe, and observing on their persons the effects of service in various climates, and the influences hostile to health to which they have been exposed; and while it is the chief duty of the Professors of the School of Military Medicine to teach the young medical officers the many valuable lessons derived from such an immense field of observation, it is no less their duty, from time to time, to give to the authorities such information as may lead to improvements calculated to promote the health and happiness of the soldier, to diminish suffering and mortality; to lessen cost, and promote efficiency. It is because I conscientiously believe that the subject to which I am about to call your attention this evening has important bearings in all these directions, that I have determined to lay it before the members of this admirable Institution, convinced that nowhere could I find an audience more capable of understanding the great practical importance of the inquiry, or more interested in its right solution.

I had not been long in the position I have the honour to fill in the public service, before I became profoundly impressed with the vast losses sustained by the prevalence in the army of consumption and diseases of the circulatory system, that is, of the heart and great vessels. Within the last three years, excluding those who die in regimental and depôt hospitals, and those of the Household troops (I exclude all invalided in Ireland, of whom we at Netley see nothing), no less than 1,344 men have been lost to the service from consumption alone. Now the causes in operation tending to produce this enormous and costly loss are many and complicated.* That the present accoutrements and knapsack, interfering as they do with the free play of the important organs within the chest, exert an important influence in this direction, I do not doubt; but as the proof of this would lead me into details, and involve many points of inquiry not suited for discussion here, I shall not go further into it on this occasion, but will direct your attention to another source of inefficiency, which can be more directly traced to the *mischievous constriction* to which we subject the chests of our soldiers at the time we demand from them the *maximum of exertion.*

Between the 1st of July, 1860, and the 30th of June, 1861, 2,769

* A very general impression prevails that the recommendations of the Royal Sanitary Commissioners as regards the amount of cubic and superficial feet per man in barracks has been universally carried out. This, however, is far from being the case. The home regulation is 600 cubic and about 60 superficial feet per man, but even this *minimum* is rarely enjoyed by the soldier.

In Chatham the average cubic space is only 450. In hot Gibraltar the Barrack Commissioners report that no fewer than 3,617 men have under 450 cubic feet each, and 5,253 have less than 40 square feet each. While such a state of things exists, we cannot be said to have taken a single step to mitigate, much less remove, what is certainly the master sin of our whole system, viz., overcrowding in barracks.

According to General Morin, the reporter of the commission ordered to determine the ventilation of the Palais de Justice and the new theatres of Paris, as quoted by Dr. Parkes, to keep the air pure there must be supplied—

In barracks, by day, 1,060 cubic feet per head per hour.
" by night, 2,120 " " " —W.C.M.

men were discharged the service at Fort Pitt; of these 445 (or 16·07 per cent.) were under 2 years' service; and of these 445 discharges, *heart diseases* made up 13·7 per cent. From the 1st July, 1861, to 30th June, 1862, 4,087 men were discharged the service; 569 of them (or 13·92 per cent.) had less than 2 years' service, and of these, 14·76 per cent. were lost to the service from *heart diseases*.

From the date of my assuming charge of the medical division at Fort Pitt, in April, 1861, to the end of last year, no less than 883 cases of diseases of the circulatory system—in other words a number nearly equal to the strength of a battalion,—have passed under my observation, and been lost to the service, and this from one class of disease; the great bulk of the cases being young men returned to the civil population (that is, cast upon their parishes), and incapable of earning their bread in any active employment. The pension allowed to such short service men is but a pittance, and that pittance is granted only for a limited period. Let me remind you again, that in the figures I have given, the invalids of the Royal Artillery, the Guards, and the troops serving in Ireland, are not included; they were discharged without being seen by us at all.

Surely, gentlemen, you will agree with me, after hearing a statement so startling, that it behoves us to look narrowly into a question involving such an amount of suffering, costly invaliding, and inefficiency, with a view to the adoption of a remedial measure.

Before I address myself to an examination of the accoutrements and knapsack, and show the evils they induce, I must advert for a moment to three causes, which are supposed to exercise a disturbing influence on the organs of circulation, and to act either as predisposing or exciting causes of disease of the heart, viz., rheumatism, intemperance, and excessive smoking.

Rheumatism affects the fibrous structures of the frame; these structures enter into the formation of the delicate valves of the heart, and these valves are apt to suffer from this disease, to have their mechanism injured, and so to interfere prejudicially with the working of the heart—the central moving power. Now, many cases of heart disease can be traced to this cause, and soldiers, from the very nature of their calling, are of course much exposed to rheumatism; but, making a fair allowance for this, particularly among old soldiers, an immense number of cases remain that cannot be accounted for in this way. A vast number of the young soldiers discharged the service for heart disease have never suffered from rheumatism at all.

With regard to intemperance, it is undeniable that the presence of alcohol in the blood exercises a prejudicial influence on the heart and great vessels, as well as on other organs, but here we have the same difficulty to meet, viz., that a large proportion of our young lads are lost to the service from heart disease ere they have contracted the baneful habit of spirit drinking.

Nor do I deny that excessive abuse of tobacco may in many cases result in an irritable condition of the heart, incapacitating a man from much exertion; but I think there is no proof that young soldiers smoke more than other classes of the population.

Is it that soldiers are called upon to make greater exertions than the labouring and manufacturing classes? Doubtless the soldier has at drills, marches, and field-days to put forth considerable exertion; but is this more than, or so much, as we see daily done by our "navvies," and others of the labouring classes? I think not. We must look, then, to the different conditions under which the two classes work. A labouring man or mechanic, when he addreses himself to his work, lays aside every weight, and every article of dress that can in the slightest degree interfere with the free movement of his chest and limbs. In like manner, the sportsman, or the Alpine tourist, adapts his dress to the work in which he is engaged. But the soldier on the other hand, is called on to make the severest exertions, at the utmost possible disadvantage as regards the weight he has to carry, the mode in which he has to carry it, and the entire arrangement of his dress and equipment.

The function of respiration in health, when we are not unduly exerting ourselves, is carried on with so much ease and regularity, that we are hardly conscious of the action of its complicated mechanism; we draw air into our lungs and expel it without an effort. It is only when we experience in our own persons, or witness in others, the effects of even a momentary interruption to the due performance of this function, that we become aware of its vital importance to our very existence. Three minutes' total suspension of respiration, and we die. So essential is respiration to existence, that it is placed under the control and guidance of a part of the nervous system apart from the will, and it is only when the function is interfered with by disease or excessive exertion, that the assistance of muscles, under the direct control of that will, is called in to aid us in the struggle for the free admission of that air, without which we die. Let us glance for a moment at the chest and its contents.

I have here the framework of the torso or trunk. Within the elastic walls of the chest are placed the lungs, the heart, and the great vessels leading from it, and these fill it equally in all its alterations of size; it is so contrived, as to shield these vital parts from injury (save of course from injury of an extreme degree), and yet to give them that free play, without which their functions cannot be performed. You observe its construction—consisting of the spinal column behind, itself made up of many separate pieces, with an elastic fibro-cartilaginous cushion interposed between its separate parts, represented artificially here, the breast-bone in front, and the ribs, or osseous arches, enclosing the chest. Note that each rib has a cartilage of prolongation; these are of great strength, and very elastic. By their means, the seven true ribs are connected directly to the breast-bone, those of the remaining ribs, merely to each other. You cannot fail to observe that there is here unequivocal evidence of a provision for motion. Let us look now at the movements to which this anatomical arrangement points.

During inspiration, the collar bones, first ribs, and through them the breast-bone and all the annexed ribs, are raised; the upper ribs converge, the lower diverge, the upper cartilages form a right angle with

the breast-bone, and the lower cartilages of opposite sides, from the seventh downwards, move further asunder, so as to widen the abdominal space between them, just below the point of the breast-bone; the effect being to raise, widen, and deepen the whole chest, to shorten the neck, and apparently to lengthen the abdomen. During expiration the position of the ribs and cartilages is reversed; the breast-bone and ribs descend, the upper ribs diverge, the lower converge; the upper cartilages form a more obtuse angle with the breast-bone, and the lower cartilages of opposite sides approximate, so as to narrow the abdominal space between them, just below the point of the breast-bone; the effect being to lower, narrow, and flatten the whole chest, to lengthen the neck, and apparently to shorten the abdomen. During inspiration, the movement of the lungs and heart is downward.*

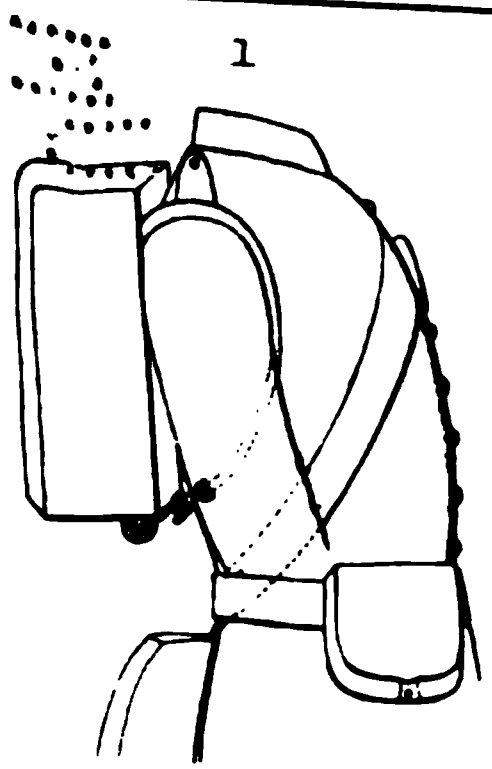
Let us now inquire whether there is anything in the mode in which the soldier is weighted and accoutred likely to interfere with these natural movements more or less at all times, and particularly when making severe exertion. And here I must take the opportunity of saying that this question has been very carefully examined by the professors of the Army Medical School; and, after mature consideration and inquiry into the whole question, we have arrived at the conclusion that the present accoutrements are highly injurious to the health of infantry soldiers, and have a large share in producing many affections of the lungs and heart common among them; in fact, so impressed have we been with the importance of the subject, that, in conjunction with Major Deshon, 2nd Depôt Battalion, an officer who has paid a great deal of attention to these points we made two reports on the pack and accoutrements of the infantry soldier, which reports were presented to the General commanding at Chatham. From these reports I shall quote largely in the course of the following observations. It will perhaps be well for me to mention that two great military nations, France and Prussia, have experienced the inconvenience of a faulty system of accoutrements to such an extent that they have introduced improvements intended to relieve the soldier from injurious pressure upon his chest and abdomen, and to interfere as little as possible with the free action of his muscles and organs,

The weight of the British soldier's clothes, great coat, field kit, and canteen, with 60 rounds of ammunition and 75 caps, havresack, bayonet, rifle, and sling, pack and straps, pouch, &c., &c., is 48 lbs. 5¼ ozs.

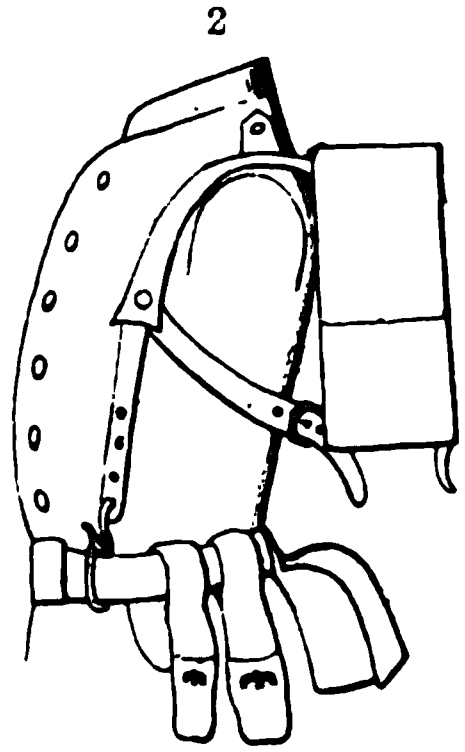
If the soldier has to carry his blanket, as in the field, with rations for three days, and his water-bottle, an addition of 12 lbs. is made, making in all 60 lbs. 5¼ ozs.

Let us now look a little closer at the regulation pack. In the diagram before you (Plate x., Fig. 1) is a drawing of it. You cannot fail to see that the whole weight of the pack is thrown on the

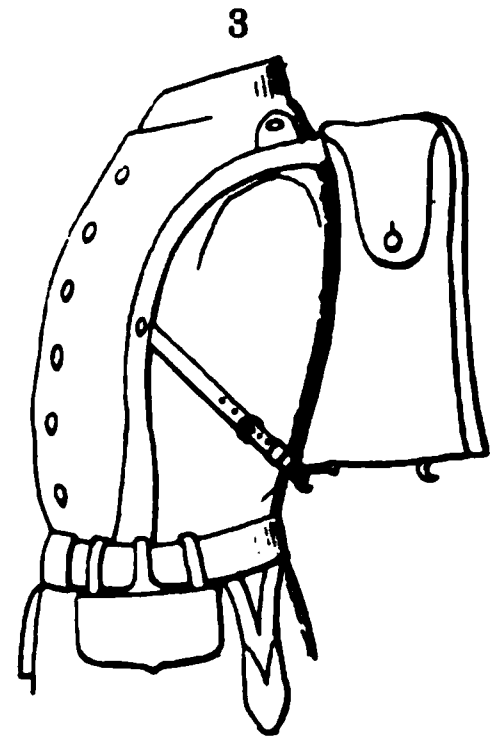
* Vide Sibson's Medical Anatomy.—Here Dr. Maclean showed a figure in outline, displaying the extent of these movements, and also a skeleton of the trunk, showing its framework, &c.—Ed.



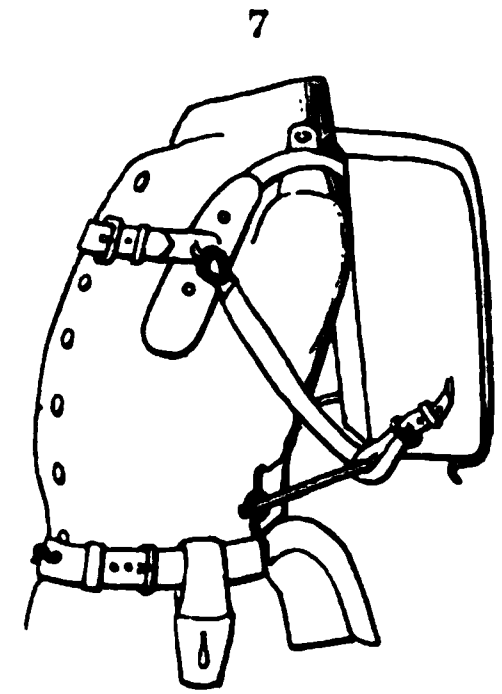
British Regulation.



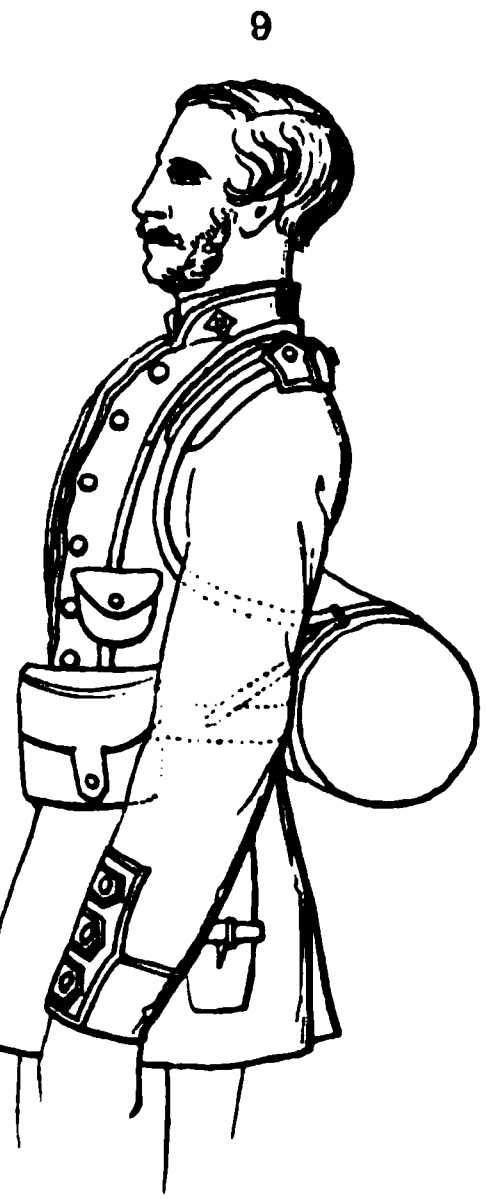
French.



Prussian.

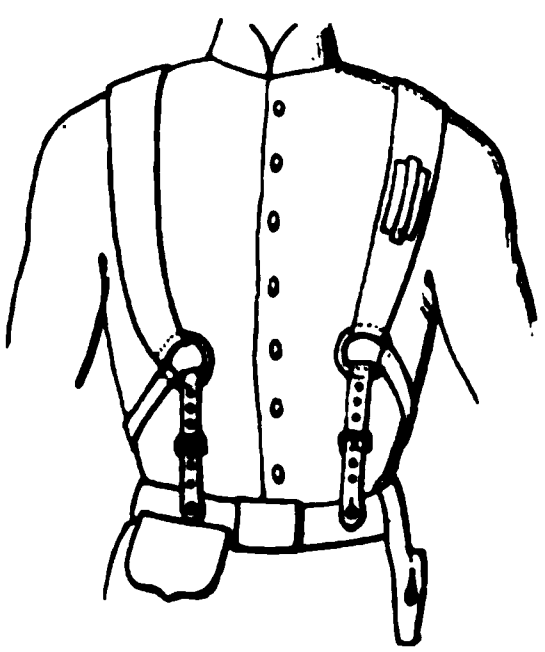


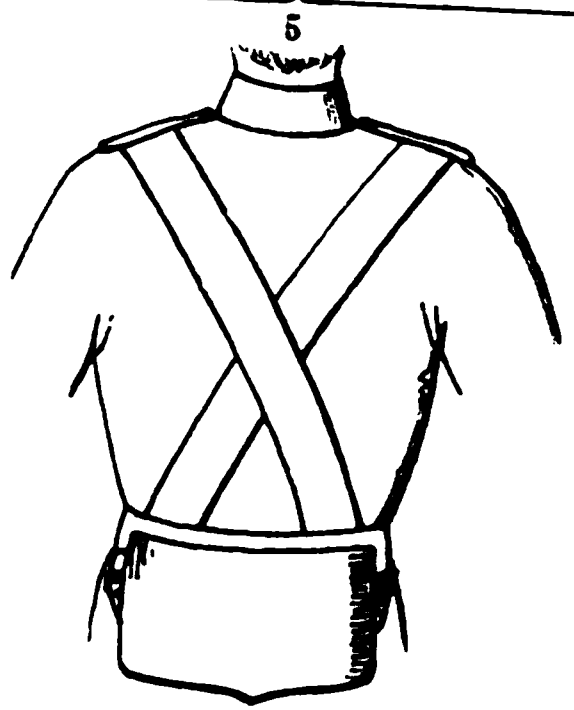
Col. O Halloran's.

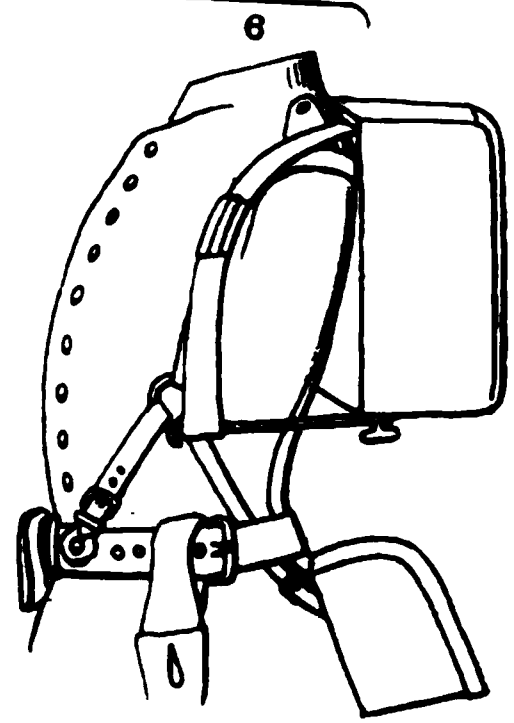


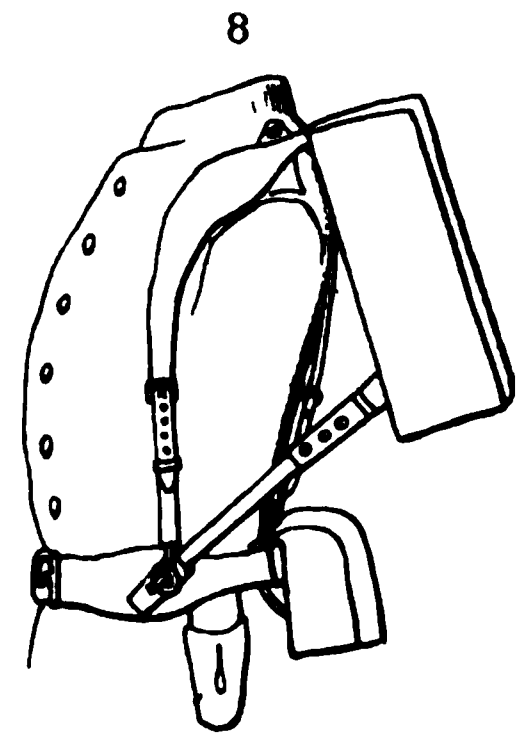
Sir Thos. Troubridge's.

Lieut. Col. Carter's.









Dr. Parkes'.

straps passing under the arms; the pouch and a small packet for caps are carried on the belt, which runs diagonally across the chest, and the bayonet and ball-bag are carried on the waist-belt; the belts are therefore so disposed as to press most injuriously on the chest; the cross-belt, stretched by the great weight of the pouch, impedes the forward movement of the ribs; the waist-belt hinders the expansion of the inferior false ribs, which, as we have just seen, in the state of unrestricted movement, is very great; and the pack-straps press on important muscles, arteries, veins, and nerves to a degree which only those who have carried the loaded pack can appreciate. The weight, especially when the great coat is strapped on, falls to a great extent behind the line of the centre of gravity. Now these objections are by no means merely theoretical; soldiers universally complain of the sufferings they endure from the pack and present accoutrements, and if you closely question the sufferers from heart disease, you will find how closely they connect their complaints with these belts and packs.*

It is certain that at no period was the pack more worn that at present. I find that it is worn at least once a day on regimental parade, and on all brigade and field days at all the camps in this kingdom. I have been at some pains to ascertain from regimental medical officers the effects observed on the men, particularly on field days. Some do not appear to have paid much attention to the subject, but the majority seem alive to the ill effects of the pack and accoutrements.

Many men fall out in a state of extreme distress, and many surgeons assure me that nothing but a strong feeling of *esprit de corps* prevents many more from doing so. In all well-disciplined regiments the practice of falling out at drill or on the line of march is discouraged, and men will bear and suffer much, rather than incur the imputation of being "soft"—some, to my own knowledge, have worked on through a field day, and have died rather than give in. An instance of this occurred at Aldershot on a field-day last summer.

In the first of the reports on packs submitted for the consideration of the General commanding at Chatham, by the professors of the Army Medical School, the following were the general principles insisted on:—

1. To distribute the weight, as far as practicable, over the body.
2. To bring the weight, as far as possible, within the line of the centre of gravity.
3. To allow no pressure on the principal muscles, nerves, arteries, or veins.
4. To avoid most carefully all impediment to the fullest expansion of the lungs, and to the action of the heart.

This rule is a cardinal one. Unless the circulation through the lungs be quite free, continued exertion becomes impossible. The commonest experience shews that the number of respirations,

* Here the Professor showed a preparation of a human heart, taken from the body of a soldier, with a white spot or corn on it, which he explained arose from the pressure and friction to which the organ had been exposed. He further stated that this "corn," rare in civil life, is the rule and not the exception in the bodies of elderly soldiers.—ED.

and the amount of air drawn into and expelled from the lungs, is enormously increased by exertion. Late physiological inquiries have shown that the elimination of carbonic acid is also prodigiously augmented, and this is a necessary sequence of the muscular contraction. If this elimination be prevented by any interference with respiration, no amount of energy or volition on the part of the man will enable him to continue his exertion. Trainers, both of men and horses, have long been aware of this fact.

I have just shown you how impossible it is to carry out such principles as these with the regulation pack, which is constructed as if for the purpose of transgressing them all.

Fig. 2 shows the French pack, that worn by the Chasseurs de la Garde. It is secured by straps going under the arms, as in the English pack; but it is an improvement on the latter, as two straps run down from the arm-straps to the waist-belt, and so relieve in great measure that excessive pressure on the arms so much felt by our men. It approaches the Prussian pack, but is not so good; the pouch (which is small) is carried on the waist-belt behind, and there is no cross-belt whatever; the lungs have therefore very fair play with this pack, the amount of ammunition is, however, smaller.

Fig. 3 shows the Prussian pack and accoutrements. You see that they are arranged differently from any of the others. The ammunition is carried in two pouches attached to the waist-belt, capable of carrying each 20 rounds of English ammunition, and 15 of Prussian. The pack fits to the back, to which it lies as close as possible. Two broad straps pass from the top of the back over the shoulders and fall to the waist-belt, to which they are joined by two brass hooks.

Two other straps run from the lower part of the pack and join these shoulder-straps, so that the pack is quite steady, and its weight is counterbalanced by the pouches in front.

This pack is much superior to ours; it exerts only moderate pressure on the lungs, and none on any muscles or vessels; the weights are close to the body, and the weight of the pack falls within the centre of gravity. The arms have full play. In the trials conducted by us, this pack was invariably preferred by the men to our own, although it was not rated so highly as others.

Figs. 4 and 5, show front and back views of Lieutenant-Colonel Carter's accoutrements. Fig. 6, side view of accoûtrements and pack. The pack is supported by two straps passing over the shoulders and hooking on to two iron rods, which project forward from the lower end of the pack; the front of the pack is concave, and is made of wicker work; its weight is very great, and it is altogether too large.

It is, however, a vast improvement on the regulation pack. It is borne on the shoulders, and does not press at all on the lungs, or upon any muscles, nerves, or vessels; the arms are quite free. The pouch, which is a large one, hangs away from the body too much. It is, however, carried easily. The belts are too heavy and complicated. In our trials the men reported favourably on this pack, all who tried it declaring it to be an immense improvement on the regulation pack.

The next is Berrington's pack, adapted with Colonel Spiller's rods by Colonel O'Halloran (Fig. 7). The belt represented in this drawing as passing across the chest is done away with in Colonel O'Halloran's improvement pack.

It is carried by means of two flexible steel plates lying in front of the chest, and having attached to them two straps passing from the lower end of the pack beneath the arms. Two rods, with a broad strap between them, support the lower part of the pack against the small of the back; no muscles or vessels are pressed upon, and the arms are perfectly free. The weights are tolerably close to the centre of gravity. With this pack, the pouch and bayonet are carried as in the regulation pack. The steel plates were thought by us an objection to this pack, as by their breadth they, in some degree, press on the ribs in inspiration. The pack, however, in our trials was favourably reported on.

A pack contrived by my colleague, Dr. Parkes (Fig. 8), was also tried. The principle of it is to throw the weight in part on the hips, by means of two straight iron rods running from the bottom of the pack, and fitting into two sockets in a hip-belt. The principle of this pack is sound, but there is great objection in this, as in the others, to the iron rods, which, if broken on service, cannot easily be replaced. They are also dangerous, for if struck in action the fragments would almost certainly be driven into the body of the wearer, or that of a comrade in the ranks. The conclusion come to by us, after a careful examination of all these packs, and carefully conducted trials with them all, was, that the regulation mode of carrying the pack was the worst of all; but good as some of the proposed plans are, none of them seem perfectly to answer all the required conditions.

Lieutenant-Colonel Carter and Colonel O'Halloran were not the only officers who saw the necessity of introducing a new and a better mode of carrying the pack.

Sir Thomas Troubridge exhibited at the last great Exhibition a valise, which I now show you (Fig. 9), and on which we (the professors) made a special report to Major-General Eyre, Commanding at Chatham, an officer who has taken a great interest in this question, and who gave us his cordial co-operation in investigating it.

This pack is carried in a mode different from any of the others. A yoke, on the principle of the milkmaid's yoke, is fixed on the shoulders; from this two metal rods (of tubular copper or of steel) pass down in front of the arm-pits, which they do not touch, and are hooked behind to a round bag or valise (without any frame), which is carried on the small of the back, or just above the hips. The weight of this valise is chiefly thrown on the shoulders, but it is also partly thrown on the strong hip-bones, in this resembling Dr. Parkes'. There is not the least pressure, either on the chest or on the arm-pits.

As the valise is thus carried so low down, the ammunition cannot be carried in a pouch behind. It is, therefore, placed in two pouches in front (each intended to carry thirty rounds), and a strap passes round the back of the neck, and hooks into each pouch.

A waist-belt carries the bayonet, and keeps the two pouches steady;

the pouches thus balance one another, instead of, as in the Prussian plan, the pouches balancing the pack.

The great-coat can be carried either on the top of the valise, or in a roll over the shoulder.

On considering the mode in which the weights are distributed on this plan, it is evident that it satisfies all the conditions which we formerly enumerated as essential to a perfect system.

Not the slightest pressure is made on the lungs; no great muscle, vessel, or nerve, is pressed upon; the weights are close to the centre of gravity, and are as near the line of the centre of gravity as they can be; while the strongest parts of the body, viz., the tops of the shoulders and the hip-bones, carry the weights.

As far as mechanical and physiological principles are concerned, we see nothing wanting in this plan. The weight, in pounds and ounces avoirdupois, of Sir Thomas Troubridge's valise, with kit, ammunition, &c., is 17 lbs. 12⅔ oz.

Any one who has seen the enormous weights carried by the Canton water-bearers, or the Banghy Burdars and palankeen-bearers of India, all borne on the shoulder, in such a way as not to interfere with the free play of the chest, will see that Sir Thomas Troubridge has thus hit on the right principle for carrying the soldier's pack and ammunition. We submitted this plan to a trial against O'Halloran's pack, as improved and exhibited in the last Great Exhibition.

Four experienced non-commissioned officers, and privates, after being carefully examined by me to see that they were free from chest disease, were marched eleven or twelve miles accompanied by Major Deshon, who closely watched them: they used the pack and valise alternately, and on returning, their unprompted statements were taken down by me verbatim. Without going into details, I may say that the reports of all the four men were identical: they all praised Colonel O'Halloran's pack, and thought it much better than the regulation, but they reported of the valise that it was as superior to Colonel O'Halloran's pack, as that was superior to the regulation.

The ease of breathing, the freedom of the arms, the apparent lightness of the weights, the absence of fatigue or exhaustion at the end of the march, with Sir T. Troubridge's accoutrements, were all points strongly insisted upon by these experienced non-commissioned officers and soldiers; nor did they hesitate to affirm that the efficiency of the soldier would be increased to an immense extent by their adoption throughout the service.

In conclusion, I trust that some of the distinguished officers present may be induced to inquire into this subject for themselves, to make comparative trials with the packs just exhibited, and with the contrivance of Sir Thomas Troubridge; if any can be induced to do so, and to investigate it thoroughly, I feel convinced they will find that my colleagues, and the gallant officers who have cooperated with us, have not exaggerated its importance. I am quite aware that the introduction of a new knapsack into the service would be a very costly measure; but if once the fact is established that the present knapsack is costly from the amount of invaliding it

entails, and cruel from the suffering it causes, enough will be done to warrant, at least, the gradual introduction of a better. To an audience such as this, I need hardly add, that the tendency of modern tactics, all over the world, is to rapid movements in the field, and if it is insisted on, that modern soldiers shall march and fight with their kit on their backs, it is obvious that this should be so placed, as to embarrass their movements to the smallest extent, if not they must fight and march at a grievous disadvantage.

The CHAIRMAN: I am sure Dr. Maclean will be ready to answer any question that any gentleman may wish to put, or should any gentleman wish to illustrate the subject by mentioning the results of his own experience, we shall be very glad to hear him. If no one has any observations to make, I am sure you will now join me in a vote of thanks to Dr. Maclean for the interesting lecture we have had, and for the able manner in which he has delivered it.

We will now proceed to call upon Dr. Domenichetti to begin his lecture.

SICKNESS CHARTS ILLUSTRATING DISEASES, &c., OF THE ARMY.

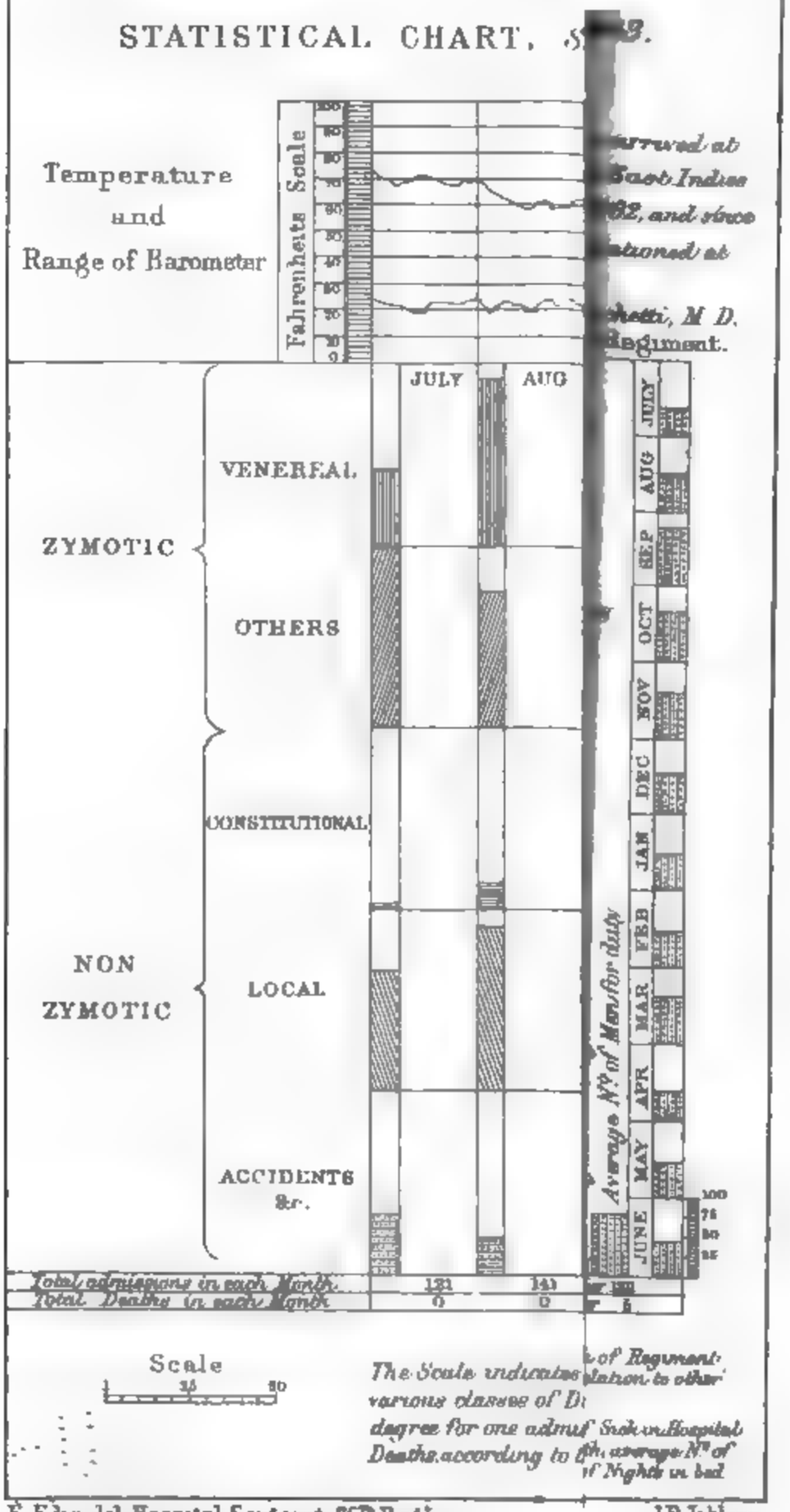
By R. Domenichetti, Esq., M.D., Surgeon, 75th Regt.

Mr. Chairman: I am desirous of introducing to the notice of the meeting this evening, the subject of a statistical chart, intended to illustrate the diseases of the army. This is no novel idea; it originated (so far as I am concerned) as far back as the year 1847. I may observe that I had occasion to see and inspect a chart by Captain Edwards, of the 86th Regiment, who presented it to Sir Charles Napier. It was intended to show different meteorological phenomena of the climate of Scinde, which country had just been occupied by our troops. He undertook to illustrate the rise and fall of the river Indus, the various phases of the moon, and other meteorological phenomena connected with the country. It occurred to me, that it would be exceedingly desirable to adapt the same principle to the illustration of disease, if it could be done in a simple and comprehensive manner. Accordingly I applied myself to the subject, and succeeded in my object, to the extent which you will perceive.

The chart to which I would first call your attention, is an Annual Chart with a simple scale (see Plate XI); these other diagrams are merely divisions of the chart, for the purpose of illustration. I will commence by showing you, in the first instance, the principle on which it is arranged. It occurred to me, that if it was possible to exhibit the various diseases of the soldier classified in some simple and acknowleged form; and to show how far the temperature, the dew point, the range of barometer, and other meteorological characters, could be embodied in the chart, and were their influence shown in the progress of any particular class of disease, a very great object would be gained.

This diagram illustrates the temperature. The curvilinear method is adopted. It must be perfectly familiar to students of statistics that two forms have been recommended—the columnar and the curvilinear. There is no doubt that the curvilinear presents some great advantages; for instance, the temperature is better displayed by that method. In the army, we are the creatures of routine, and the columnar, so far as diseases are concerned, is the preferable plan. We are accustomed to look forward to weekly, monthly, and quarterly reports, and our ideas run in a kind of groove; we are accustomed to look to these periods for denoting the progress of disease. And our returns also tend to that illustration. On that account I select the columnar plan, as being preferable.

In regard to the temperature, I have attempted to show its range



E Edis, del Hospital Sergeant 75th Regt

J.R.Jobbins

in outline of the Fahrenheit thermometer, as shown in the margin, and the variations in the common known way. Underneath is the dew point. The amount of rain, and other points of interest, might be shown. It was my intention to embody these different points, with the view of accounting for the progress of disease; its diminution; the phases of the moon; the direction of the wind; the amount of ozone in the atmosphere, &c. I merely throw out these hints to show how far the subject admits of illustration.

The columnar method has been followed out with regard to the classification of disease, under two heads—the zymotic and non-zymotic. I am not prepared to indorse the value of these names, because I have it from a good authority that there is a Medical Council now sitting to determine the change of medical nomenclature. I am sure it will be for the better, but in the absence of any better method I have adopted the one in vogue. Here the various classifications of disease are shown. There are columns differently coloured for the month in which they have been under review. For instance, here is a column shown by the scale to be so many degrees in height; that represents so many cases of disease in hospital. Here, again, under the head of fevers or zymotic diseases of different kinds, is a smaller column. Again, the constitutional affections still lower; and so on, denoting 217 cases, in the aggregate, under treatment on the first return day in the month of January. Those circles denote death to have occurred, and they are coloured according to the diseases of which the men died.

The great advantage of my plan, I submit, is simply this: That on a single chart may be represented the annual return of a British regiment of infantry for one year. I do not wish to bring into question the advantage of voluminous reports; but I am sure my non-professional friends will agree with me, that it is extremely laborious to pore over voluminous details, and at the end, perhaps, to arrive at little or no understanding of the subject. That has been the remark of various military authorities whom I have consulted.

When on the staff of Sir Willoughby Cotton in 1847, in India, I had the good fortune to know Sir Henry Havelock. I submitted this chart before you, to him. He, the head of the Adjutant-General's department, said, "This is precisely the kind of chart the military authorities stand in need of; we don't want accuracy of detail, but what we want to arrive at is the state of a regiment at a single glance. I see your chart is in that particular very satisfactory." And he recommended me to pursue my inquiries.

I ought to apologise to the meeting for having intruded these crude ideas upon you, but I shall be able presently to show the sanction of some high names as to the utility of this chart.

I may now go into detail in regard to the explanation of the annual chart. Underneath are figures denoting the number of diseases in hospital on the first of each month. Then there are the months during the year; and the amount of sickness and mortality are shown by these different coloured columns, graduated according to scale. Here you see the number of deaths. There were two deaths in the course

of the year. The same with the local affections. It would be interesting to watch the effect of the range of temperature, or dew points, as far as regards the progress of any particular class of disease.

It occurred to me that it would also enhance the value of the chart if a column intended to represent the strength of the regiment, say 800 men, were attached to it, and such other details as might be interesting to an officer commanding a regiment or station, *e.g.*, the number of men joined during the year, the number invalided, the number of deaths, the average number of men fit for duty. If all these points could be embodied in this chart, the commanding officer would then have in his possession all the essential particulars regarding the station or regiment. Whether this will be fulfilled from the indication in view, is for you to determine hereafter.

The same principle is also capable of being applied in another manner. Here is what is called a divisional chart. It has only lately received any share of attention from me; but it occurred to me that the same principle might be adopted on a larger scale. For instance, a general officer or brigadier, commanding a division or brigade, would be able at one glance, by means of these graduated columns, to ascertain the amount of sickness prevailing amongst the men under his command, the number incapacitated by wounds, the number killed in action. The same with the meteorological facts, which I have not noticed in this chart, but which I have indicated in the other. It is sufficient for you to follow out the idea, and see what I intend to do with regard to the system.

I will now give some sort of notice regarding the encouragement I have met with. In the year 1849, as I told you, I had an opportunity of showing the chart to Sir Willoughby Cotton and Sir Henry Havelock, both of whom cordially approved of it. I was not so successful the next year. Without being egotistical, it only amuses me to think that everybody must be prepared to encounter a certain amount of opposition in advocating any particular project, or in encountering the prejudices of those with whom he may be associated. I had occasion to send an elaborate copy of this chart to the head of my department in Scinde, expecting, of course, that it would be forwarded to the authorities. I received the following reply. The head of the department said "he had the pleasure to acknowledge the receipt of this elegant and ingenious bauble, and at my period of service he would recommend me, instead of presuming to generalise upon diseases, to attend to the individual study of disease; and in conclusion he begged to recommend me to study Abercromby on 'Intellectual Powers in the Investigation of Truth.'" This was not very encouraging, consequently the project remained dormant for a considerable time, until called into action by Lord Clyde, who saw a copy of it, and who wrote to a commanding officer of a regiment to say, that it would give him extreme gratification to see this chart and peruse it, as it had afforded him at a single glance the history of the 75th Regiment (see Plate XI), and he begged to express his high approval of it. Accordingly, afterwards Sir Hugh Rose sent for me to Calcutta, and I explained to him, as I have done here, the bearings of this chart. Since, then, some of my brother

officers have been to me with a number of the "Army and Navy Gazette," in which they saw a startling notice, as far as I was concerned. It was to the effect that Sir Hugh Rose is deserving of great credit for having adopted a new form of statistical chart, which has been forwarded to every station in India. This was my chart, and as it has not been acknowledged, I take the opportunity of giving it all the publicity. The *Lancet* spoke well of it, but objected to the columnar mode; they gave the preference to the curvilinear plan. With regard to this objection, I may refer to other statistical plans in the army.

A French medical officer, in charge of the troops at Rome, has constructed a most ingenious and elaborate chart, which was shown to me by the head of the Statistical Department; being extremely elaborate, it occurred to me that it was rather difficult of comprehension, and required to be studied. With regard to my chart, all that I had in view was to make it simple and comprehensive to the military authorities. If it should succeed in obtaining the sanction of those in power, all that would be necessary would be, not to undergo the laborious toil it has cost me in preparing it, but simply to have it lithographed, and have it filled up by any intelligent non-commissioned officer, with the least trouble in the world. Then, in the course of a few hours, the authorities would be in possession of a chart giving all the details with regard to temperature, disease, and the other points that I have specified, without incurring the labour of reading numerous documents.

Very lately I had occasion to show my chart to General Hutchinson, Lieutenant-Governor at Plymouth, who gave me great encouragement in the matter. He wrote to me on the 17th of August as follows:—

(Copy.)

Letter from Major-General Hutchinson, Commanding the Western District, Plymouth.

Government House, August 17th.

Dear Dr. Domenichetti,

I had no favourable opportunity of shewing Lord de Grey your ingenious chart. It is most clearly arranged.

I was at the Senior Department, Sandhurst, with Sir Alexander Tulloch, and remember his drawing up some statistical returns on the same principle, graduated coloured columns, showing the comparative mortality of the several West India islands, compared with other stations. The account was published in the *United Service Journal*. Met the eye of Lord Herbert, who sent for the writer, was much pleased with him, and the interview ultimately led to Tulloch's introduction into the War Office.

Yours truly,
(Signed) W. H. HUTCHINSON.

I return the chart with many thanks.

This, it appears, met with the approval of General Hutchinson, who is a great authority in military matters and in sanitary reform, having given a good deal of time and attention to that subject.

I have also got a letter from Dr. Hadaway, who was the Inspector-General with Lord Clyde:—

(Copy.)

Letter from Deputy Inspector-General Hadaway.

Devonport, 24th March, 1863.

Dear Dr. Domenichetti,

In answer to your note of this day, I beg to state that I remember pefectly having had, while at Simla, Bengal, a statistical chart referred to me, by Lord Clyde, through the Adjutant-General, Queen's Troops, and it affords me pleasure to say that I quite recollect having given a favourable opinion of it, as a ready way of elucidating at a glance the state of health of any particular corps.

Believe me, yours very truly,
(Signed) S. M. HADAWAY,
Deputy Inspector-General.

To Dr. Domenichetti, Surgeon, 75th Regiment.

I have not much further to urge with regard to critics of the press, beyond the fact that the *Lancet* has noticed my plan very favourably. I would refer you to the number of October 17th, in which the views of the editor are given.

In conclusion I may say a few words with regard to the merit, if any, which I claim in connection with this chart. Not long ago I discovered that in the year 1837 some medical officer had undertaken to show the comparative mortality of black and white troops by means of coloured columns. These you may say are crude ideas, and not followed out to the extent that the present system proposes. It seems that Sir Alexander Tulloch has done the same, and it has been done before. But it had never been worked into a system. There are other charts, too. The Crimean war made us familiar with the columnar and curvilinear mode of depiction. These dates speak for themselves. All I say is, that in the year 1847, these little charts were but little thought of, and it was only during the Crimean war that the subject received particular attention. I think, therefore, a very fair share of originality may be due to me, so far as adapting them to diseases. I have only to thank you for your courtesy in listening to me, and I shall be glad to hear any remarks with regard to the plan that I have had the honour to introduce.

The CHAIRMAN: I am sure you will all join me in returning our thanks to Dr. Domenichetti for the explanation he has given of his very useful chart, which I think would be of great service to commanding officers. As there is little time left for discussion, I may venture to state that Dr. Domenichetti's chart, among other things, shows the prevalence of one class of diseases in garrison towns, a subject which happens to be at the present moment very much before the public. It is a subject that is very difficult to talk about, but it is one that will undoubtedly have to be dealt with. In the chart, that complaint stands in the highest line, and its prevalence renders the army very inefficient at times. The subject is peculiarly fitted for consideration by this Institution, which takes interest in every thing relating to the health, welfare, and efficiency of the two services. Therefore, I think I am right in announcing that if any gentleman wishes to introduce that subject, this will be the proper and probable the only opportunity of doing so.

Dr. BALFOUR, Deputy Inspector-General: Mr. Chairman, I rise with very great reluctance to make a few remarks upon the Tables which Dr. Domenichetti has submitted. They are extremely ingenious, and I am willing to give him all credit as the inventor, because, I believe, before he brought them forward himself, he had not seen any that had been previously introduced. There are two points, however, on

which he has made a mistake, which I think it necessary to correct. The first is, the date to which he goes back as the period at which these columnar Tables were first introduced, and which, I think, he stated to be 1847. To my certain knowledge they were in use ten years before that. The second point to which I would refer is General Hutchinson's letter, in which he states that Sir Alexander Tulloch had published some statement of the kind in the military journals, which had been brought under the notice of Lord Herbert, that Lord Herbert sent for him, and that it was to that that he owed the introduction to the War Office. It happened, that in 1836 and 1837, Sir A. Tulloch and I, he then being a subaltern in the 45th Regiment, were employed by the Government in preparing a report on the health of the army serving in the Colonies. We prepared columnar tables, in which we illustrated the different diseases among black and white troops, in the different islands and stations in the West India command. That was at least ten years before the period which Dr. Domenichetti has named as the origin of this method of illustrating disease. We applied it only to the West India Report. I believe, a well-arranged table, showing the ratio per thousand illustrates the mortality at different stations, from different causes, and at different periods of the year, quite as well, in a much smaller space, and with considerably less trouble, than the method which Dr. Domenichetti has brought before us. Another objection, I think, to Dr. Domenichetti's mode, is that in preparing these columnar tables you are obliged to do the work twice. You must first do the figure work, you must add the numbers and calculate the ratios, before you can prepare your tables. The columnar tables, therefore, are merely another mode of illustrating the figure tables. They have also this great objection. If you publish a report, such as is now published annually as part of the Army Medical Department Reports, and illustrate all the classes of diseases under which the troops suffer, at all the different stations, by means of such diagrams, you must almost publish a library instead of a volume; and even if you could condense it into a much smaller space than I imagine would be requisite, the expense of publishing lithographed tables in the form of a report would be so great, —I speak with some experience—that it would materially diminish the value of these reports. The advantage of these reports I hold to be, that you are enabled to circulate very extensively information regarding the health of the army; whereas, if you go to the expense of lithographed tables to illustrate it, the book itself would cost two or three pounds, instead of four or five shillings. I think this of itself is a very serious objection. I am quite willing to admit and I feel that the tables are very interesting to look at; but in preparing reports, as we are obliged to do, including the condition of large bodies of men scattered all over the world, and keeping the different military commands and the different stations separate, I think it is a point of the utmost importance to condense our information into the smallest possible space. I am sure that any one who has been accustomed to look at figures, in consulting one of the tables, would be quite able to apprehend the subject as well as if he were to look at these columnar tables. I am extremely sorry to be obliged to make these remarks after the complimentary manner in which Dr. Domenichetti has spoken of me in his remarks.

Dr. CRAWFORD: There is another serious objection not only to the ingenious tables of Dr. Domenichetti, but to all forms of coloured tables and diagrams; and that is, the public have no means of criticising them. With regard to disease in particular, every man knows what 150 cases of fever means, but he does not know what a square inch of fever means. I think that is a very serious objection to all these diagrams, and one that is felt by all who are not able to go to the sources of information, or to appreciate the principles upon which the tables are constructed. I do not mean to say that they are not constructed upon principles which are capable of confirmation, but I mean to say that every person is not able to understand the principles on which they are constructed.

Dr. DOMENICHETTI: With regard to the remarks which have fallen from the first speaker, I may be allowed to mention that, with regard to dates, if I remember right, I admitted that the plan was first tried in 1837, but it was in 1847 that the first columnar chart was brought out. Then, with regard to the objection which has been raised very justly against this method of delineation, I would observe that I never

for a moment supposed that this form of chart was to supersede either written returns or figure reports. It was merely as it were an illustration of a subject, which was only imperfectly conveyed by voluminous reports and documents, which are never perused by the majority of non-professional people. I allude more particularly to the military branch of the profession, and I appeal to them whether in their various years of service in various parts of the world, they have taken the trouble to make themselves acquainted with the statistics of returns of stations. Take the blue-books of the inspectors, and I ask, how many have taken the trouble to wade through them, unless they are lovers of statistics. It will be seen that it is by means of these charts that we would assist those who are studying statistics, not to make them absolutely dependent upon them. Of course, figures are more to be depended upon than any coloured diagrams whatever. It is merely with the view of making a dry abstract subject popular, that I have introduced these charts at all. Military officers have appreciated them, and have said that they enable them to know exactly the state of the regiment, as much as they require to know, without being bored with reading documents which they do not understand.

The CHAIRMAN: If no other gentleman has any observation to make, I believe the business of the evening is concluded, with the exception of a vote of thanks to Dr. Domenichetti for his kindness in reading this paper; and we must include those gentlemen who have kindly taken part in the discussion.

Evening Meeting.

Monday, April 4, 1864.

Captain E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 22nd March and the 4th of April.

Farquharson, G. McB., Capt. 20th Regt. H. M. Bombay, N. I. 1*l.*
Teal, Wm., Asst.-Surg. 91st Highlanders
Prendergast, G. A., Capt. H. M. 5th Bengal Cav. 1*l.*
Gregson, J. D., Ensign, 40th Regt. 1*l.*
Hooker, F. E., Esq., Med. Dept. 1*l.*
Morton, G. de C., Ensign 6th Regiment. 1*l.*

ARMY INDUSTRIAL EXHIBITIONS.

By Captain Frank Bolton, 12th Regiment, F.R.G.S., Assoc. Inst. C.E.

When we consider that the British soldier of the present day has a great portion of his time unemployed, it becomes a question of no little importance to inquire how this leisure time can be occupied profitably, or, at any rate, in such a manner as to prevent the many evils which idleness necessarily induces, and which are so highly detrimental, morally, physically, and intellectually to any man, no matter whether he may be engaged in military or other duties. With a view to the attainment of this very desirable end, much has been done within the last few years, by the establishment of reading and recreation rooms, gymnasia and soldiers' institutes, in addition to regimental schools, and no doubt exists, but that, by their instrumentality, the moral and mental condition of the soldier has been considerably improved, still, as all must admit, who have any intimate knowledge of the interior economy of barrack life, there is even now a something wanting to occupy the attention of a man who has many hours nearly every day at his own disposal. I will take, for example, the ordinary daily employment of the duty infantry soldier in permanent camp or garrison, as representing the greater portion of the army.

He is compelled to rise early; and during the summer time attends drill for an hour or so before breakfast about twice a week, his other daily duties or parades might on an average be considered to occupy

about three hours. After this he dines, and having cleaned his arms and accoutrements thoroughly, and perhaps attended a roll-call parade, he has finished for the day. In the winter months, one hour's drill in the forenoon and one in the afternoon, is about as much as is exacted from him.

Of course, when required for guard, picquet, or other regimental duty, he may be longer engaged, but as a rule between réveillée and retreat, one half of the day is entirely at his own disposal.

Now if he is a reading man, and of steady or studious habits, he will probably go to the library or to school, or amuse himself with a book in barracks, but the greater number of the men go out for what they call a walk, but in reality to visit the public-houses, music and dancing halls, and such like places, the result being in all cases a complete waste of time, and in many cases, drunkenness, rioting, and absence.

It is a mistaken notion that many entertain, that the character of the common soldier is degraded, and that all efforts would be unavailable to render him an intellectual and civilised member of society.

It must be admitted, that, in many instances previously to joining the service, he is thrown upon the wide world without a friend, and without any definite pursuit, in which he can employ his energies. He therefore enlists, and passes a life, when there is peace, in comparative idleness, and without any specific object in view, but the mere passive observance of the duties which are enforced upon him. But ought we not to believe the human mind to be so constituted by a superior Being, that under favourable auspices, and Christian philantropy, amidst whatever difficulties and disadvantages mankind may labour, by proper and judicious treatment, and holding out opportunities tending to their amelioration, they would respond and meet, half way, the advances that are made to them? Prejudice may be very strong, but experience has, in innumerable instances, proved how far it may be misplaced, and how soon, by making use of proper means, *that* prejudice can be removed. Our greatest discoveries have met with the greatest opposition, but how soon this opposition ceases when success attends our attempts? Who would believe there was a world existing in the far west, when Columbus first made his application for support to the several monarchs of Europe? Who could ever have anticipated a few years ago, the improvements which science and indomitable perseverance have achieved with regard to steam, railways, telegraphs, and other momentous advantages, which now astonish and benefit us? There exists surely no man, in the present age, so completely enveloped in the mists of ignorance, who would oppose a system for the enlightenment and advantage of so numerous and important a portion of the community as our British soldiers.

To my certain knowledge, there is no class of Her Majesty's subjects more open to improvement than the subordinates of the army. But few efficient means have hitherto been adopted, to give them a fair trial. It is true some steps have been taken, which have already been attended with very good results. This fact, then, should animate us to

further attempts, and stimulate our exertions to effect so desirable a consummation as the moral and mental improvement of a large, a useful, and an indispensable class of mankind.

There can be no doubt but that the soldier, when he finds himself an object of consideration and esteem, will not be wanting, on his part, to manifest a grateful feeling, and show himself worthy of the confidence reposed in him. At all events, it is a duty incumbent on ourselves, to make the attempt. Even should we fail, we should have an inward satisfaction of having made the trial, but I am perfectly convinced there need be no fear of any failure.

Having thus briefly endeavoured to prove the claim which soldiers have upon our regard and sympathy, let us, in the next place, devise and carry out some plan for bettering and exalting their position. Many of them were possessed of some craft, or means of obtaining a living, before their enlistment. Some of them have been skilful artisans, and are still well acquainted with their avocations as tradesmen. Let then some well-conducted system be introduced, under the superintendence and encouragement of their officers, which shall promote a habit of industry and emulation amongst them, and there can be no question but that much of their leisure time will be devoted to creditable and useful employment, and crime and misbehaviour thereby be diminished.

By means of Industrial Exhibitions, a fair opportunity would be opened for them to exercise their ingenuity. Let these Industrial Exhibitions be periodically held, prizes be awarded for skill, and proper remuneration for labour, and no doubt, the results would be most beneficial, for wherever the soldier may be located, he will find he has specific and praiseworthy means of employing his superflous time, and whilst he is occupied in a pursuit that must produce a pleasure in his own breast, he is also gaining the approbation and encouragement of his superiors.

As Government has already done so much to provide amusement, recreation, and means of mental and bodily improvement for the soldier, by the introduction of the institutions I have just referred to, surely it is not too much, to expect that the soldier himself should do something to contribute towards the same end, and I feel fully convinced that he would do so, if properly encouraged and directed by his officers. Subservient as he is to discipline, he will *not* take the initiative, but only let him have the way pointed out to him and he will follow it willingly and cheerfully without expectation of further reward than the well-merited praise of his superiors; how much more he will do so, with the prospect of reaping a pecuniary benefit, I need hardly say. Now there is nothing to prevent the periodical establishment of Regimental Industrial Exhibitions, which may be entirely self-supporting, and the plan could be carried out without in any way interfering with the efficiency, discipline, or interior economy of a regiment. The objects of these Exhibitions would be the bringing to light the ingenious contrivances of working men, to show that hours well improved (instead of being spent in idleness or worse still, in the canteen or public-house) may produce results astonishing to the men

themselves, to keep mechanics and those who have been brought up to certain useful trades in practice, so that when required their services might be made available for the benefit of their comrades, and to develope such latent talent, as may be now lying dormant amongst the men, of which I have every reason to believe there is much more than is generally imagined. Now we must consider those points in a military sense, and inquire how far they can be carried out without clashing with the present system of barrack life, and also what amount of actual good or benefit either to the soldier himself, or to the service generally, might be expected to accrue therefrom, and to enable a better conclusion to be arrived at, perhaps it will assist us if I here give a history of the origin, progress, and objects of the Exhibition, made by the 2nd battalion of the 12th Regiment stationed in the Richmond Barracks at Dublin, in January last.

In October last year, the idea was first thought of by Colonel A. Ponsonby commanding the battalion, who, after having submitted it for the consideration of several of his officers, and being assured of their cordial co-operation, convened a meeting of the soldiers of the regiment, in the reading-room of the barracks, which meeting was numerously attended, and the project was then thoroughly explained to them.

1stly. The Exhibition was intended to give those who were willing to work for it, something to amuse and instruct them during their leisure hours.

2ndly. Such articles as they contributed were to be sold at a price a little above their actual cost, as the object of the Exhibition was employment, not profit.

3rdly. To show the public generally that the soldier was not a useless member of society.

After this explanation of the project, and the scheme having been warmly taken up, a committee was formed consisting of four officers, and three non-commissioned officers, with the commanding officer as president, two of the officers taking upon themselves the duties of secretary and treasurer: and it was left to this committee to devise means, and carry out the objects of the Exhibition.

The first step taken was to circulate amongst the officers a guarantee list, so that in the event of failure all expenses might be covered; this call was warmly responded to, and over £150 was voluntarily guaranteed by the officers, and about half this sum advanced from time to time as required, to meet the current expenses. The committee then divided itself into two sub-committees, each taking a wing of the regiment, and they collected the names of all the intended exhibitors, the description of the articles proposed to be exhibited, and the probable space such articles would occupy.

When all the exhibitors' lists were collected, the articles were arranged into nine classes, under the following heads:—

Class 1. Comprising carpenters' work and cabinet-making.
Class 2. Military engineering instruments, accoutrements, and equipment.

Class 3. Leather-work, &c.
Class 4. Men's needlework and clothwork.
Class 5. Hardware, jewellery, models, &c.
Class 6. Photography, drawing, and miscellaneous articles.
Class 7. Women's needlework, embroidery, &c.
Class 8. Work done by the children and infant school.
Class 9. Armourer's work.

A statement was then prepared of all the materials required by the intended exhibitors, as also the tools and instruments necessary to enable them to execute their work.

This statement was of a very miscellaneous nature, and as it was decided that it would be unwise to trust the men with money to purchase the materials and tools for themselves, it was resolved to procure them from the tradesmen in the town, by written orders signed by two members of the Committee; that is, by the member to whose wing the exhibitor belonged, for whom the requisition was made, and by the Secretary. The tradesmen's bills were rendered weekly, and duly paid by the treasurer, after having passed the Committee. All the carpenters were set to work in a spare barrack-room, where a turning-lathe and other necessary appliances were placed, the senior non-commissioned officer, or oldest soldier present, being responsible that good order was preserved.

The men employed in leather work, worked in the shoemakers' shop; those doing cloth work, either in the tailors' shop or in their own barrack-rooms, while a second spare room was set apart for the other exhibitors, such as those who were making models, hardware, accoutrements, and articles of equipment.

A printing press was set up in the orderly room, and part of an officer's quarters was turned into a photographic school.

Thus, about the middle of October, everything was got fairly in train, and the making of the various articles commenced, the men working with zeal and ability, and evidently much to their own satisfaction. As each article was completed, it was brought in, and delivered over to the care of the Committee, who marked it, estimated its actual cost, added a percentage thereto for general expenses and profit, and then placed it carefully away until the time of the exhibition, which it had been decided, should take place on the 12th January. During the time the men were at work, they were constantly visited by the Committees, who afforded them any assistance they required.

I may here remark that many of the exhibitors provided everything they required for themselves, and some needed, and received, only partial assistance.

It was at first intended to have held the Exhibition in barracks, but as no room could be obtained suitable for the occasion, it was ultimately decided to hold it in the Rotunda.

There were many difficulties to contend with in carrying out this scheme, such as officers going on leave, men being away upon furlough, &c., but as all who took an interest in it, used their utmost exertions to command success, these difficulties were overcome, and the Exhibi-

tion promised to be of so interesting a nature, that Colonel Ponsonby submitted it for the approval of the General commanding the troops in Ireland, Sir George Brown, who at once gave his sanction for its being thrown open to public inspection. His Excellency the Lord-Lieutenant kindly consented to patronise the scheme, and open the Exhibition.

In the beginning of January the intended exhibitors numbered over 70, while the articles to be exhibited were more than 250.

The Rotunda having been hired for one week, it was appropriately decorated with military devices and banners; the arms and armour used for the decorations having been lent for the occasion from the Dublin Armoury, by the Right Honourable the Secretary of State for War.

As the day approached upon which the Exhibition was to open, much anxiety for its success prevailed, but everything was so organised by the Committee, that no hurry or confusion occurred. All the articles were duly placed on stalls under their respective classes, and stall-keepers appointed from the exhibitors, who were furnished with price lists of every article under their charge, and written instructions as to the sale and delivery of the goods. The Exhibition was then opened to the public at 12 o'clock on Tuesday, the 12th January. On the arrival of His Excellency the Lord-Lieutenant at the Rotunda, he was received by a Guard of Honour, and while he was entering the building, the band of the regiment played the Regimental March, and continued playing until His Excellency was seated on the dais. Then Colonel Ponsonby stated the objects and purposes of the Industrial Exhibition in the regiment under his command, and His Excellency having replied thereto, the National Anthem was sung by the band and chorus of the regiment, at the conclusion of which the barriers were removed, and the Exhibition declared duly opened. The band next performed an opening march, composed expressly for the occasion, by the band-master of the regiment; and His Excellency and suite, and other visitors proceeded to inspect the various articles exhibited.

This formed the opening ceremony.

At a luncheon given by the officers on this occasion to the Lord Lieutenant and the garrison, his Excellency in his speech alluding to the ingenuity and enterprise of the men, said, "They have shown us "to-day they are as good proficients in the arts of peace, as we are "sure they would be in those of war, and I think we all owe them a "debt of gratitude for showing us what can be done in the internal "life of a regiment, because I conceive it to be very much owing "to the encouragement and development of the regimental system, "that the characteristics and peculiar efficiency of the British army "belongs."

The Exhibition was kept open for four days from 12 to 5, and from 7 to 10 in the evening; the soldiers of the garrison being admitted gratuitously from 5 to 7 o'clock. The price of admission was half-a-crown on the first day, and a shilling afterwards.

I have thus stated the origin and progress of the Industrial Exhibition of the 12th Regiment, and will now say a few words

about the articles exhibited, and the results which attended the enterprise.

In the first class, the articles of cabinet-making and carpenters' work exhibited numbered 34, being the work of 8 exhibitors, and consisted of portable washing-stands, officers' tables, book-shelves, sets of pigeon-holes, cigar-boxes, racket-bat cases, stereoscopes, fives bats, camp-stools, paper-knives, specimens of fretwork, billiard cues, brackets, and sundry other articles.

The workmanship in this class was particularly good, and every article was sold on the first day of the Exhibition.

In addition to this class, 4 exhibitors combined their handicraft together, and produced in the course of a few hours, that which formed one of the most attractive features in the Exhibition, viz., a complete model of a compartment of an officer's hut, containing every requisite, as a table, two chairs, washing-stand, bedstead, cupboard, shelves, clothes-pegs, portable stove, and cooking apparatus. All these articles were substantially and well made, and the experiment was to show, that in the event of the necessity arising, an officer need not look further than his own regiment for those necessaries and comforts which, in a distant clime, or on service in the field, he might otherwise have been a long time without.

In class 2, were exhibited all such articles as came under the heads of military engineering, instruments, accoutrements and equipments, the number of exhibitors were 11, and of the articles exhibited 24. One of the articles of accoutrement was the invention of a private in the regiment, and is quite worthy of mention. It was a proposed improved ammunition pouch, and new method of carrying the same by which the pressure would be taken off the chest. The bottom of the pouch was made to open by compartments, and by merely pressing a button the flap fell down, and a packet of ten rounds of ammunition was received in the hand, for distribution in the ball-bag. The straps for carrying the pouch came from the centre to the side of the pouch, crossing at the back, and passing over and round each shoulder. Sir George Brown took particular notice of this improvement, and complimented the inventor very highly on the talent he had displayed in its contrivance (for he not only conceived the idea, but carried it out himself). There were also exhibited in this class a model of an improved movable target, some electric and scientific instruments, a proposed new method of carrying the knapsack without shoulder-straps, thereby removing the pressure from the chest. A model of a fortified house and bridge, an improved bullock trunk, containing an officer's camp-bed complete. A suit of an infantry soldier's clothing, as it should be in the opinion of the non-commissioned officer who made it, and which in many respects was vastly superior to the clothing as it now is, improved regulation boots, gaiters, braces, and stocks, and a portable field writing-case.

In all these articles, much ingenuity and ability were displayed, and many of them were of very superior workmanship.

In class 3, which consisted of leather work, &c., there were 12 exhibitors, who contributed 26 articles, comprising boots, shoes, slippers,

a pony saddle, cigar-cases, cricket-bat-cases, whips, and gaiters. One serjeant exhibited a most ingenious pair of slippers, with the upper part all in one piece. A private produced some braces and stocks, well worthy of remark, being in every respect equal to, and sold at a less price than the ordinary regulation articles. The other articles of interest in this class were some capital pairs of gaiters, and boots of excellent workmanship.

The present regulation gaiter is both unsightly and uncomfortable, and a non-commissioned officer brought forward a reversible gaiter of his own contrivance, consisting of stout white canvas on the one side, and brown leather on the other—the first for fine weather, and the latter for wet. The gaiter was fastened without buttons by means of a lace; and, altogether, was very sightly, and promised to be of much greater durability than the one at present in use in the service.

The fourth class comprised articles of men's needlework and clothwork, and in this class the chief features were the bright colours of the patchwork quilts and rugs made from pieces of old regimental clothing, the making of which had afforded pleasant occupation for some months to many men, who would otherwise have been idle. Some of these quilts were of good workmanship, and the designs were both original and effective, the cloth being cut up in little squares of about an inch in size, and sewn together in the shape of stars and other devices, and employing in their construction more than 1,000 or 1,500 pieces, according to the size of the quilt. There were eight of these rugs or table-covers exhibited, and they realized prices of from £2 to £6 each. The other articles exhibited in this class consisted of Berlin wool hearth-rugs, wearing apparel, and bead work, of which there was a goodly display.

Class 5, representing the work of the men in hardware, jewellery, and models, contained a most interesting assortment of articles. A pile of gold exhibiting the amount of gold-leaf obtained from half a sovereign, prepared by Private Bewley (a gold-beater by trade), was very much admired and was purchased by His Excellency the Lord Lieutenant. This exhibitor also showed a case containing all the articles used in his trade, and gold in the various stages of gold beating, from the nugget to the perfect leaf. Next in point of interest came some thermometers and crucifixes, made from slate, and their novelty and excellent finish, well entitled their maker to the amount of praise he received. There were altogether 27 exhibitors in this class, and the other articles shown were kaleidoscopes, mountings for riding whips, a model of a coach of the Elizabethan period, a sectional model of a merchant barque, fishing-rods, improved fire-fan bellows, a model of Richmond Tower, a French clock mounted on slate and alabaster, a stand for a lamp, some dog whistles on a new principle, a pair of razors, inkstands, a sun-dial, a lever clock and watch, a set of marquoise scales, portable brass clothes-pegs, some bracelets and gold and silver scarf pins, and other ornaments.

Class 6 consisted of photography and drawings, and other miscellaneous articles. Here there were 12 exhibitors, and the specimens

of art exhibited, comprised three large frames of *cartes de visite*, groups, and vignettes, all taken by photographers in the regiment; two excellent drawings in chalks, a map of Ancient Greece, paintings in water-colours and military drawings, coloured photographs, sketches in oil and water-colours, a collection of 256 botanical specimens collected in the Crimea after the fall of Sebastopol, by Dr. Birnie, and specimens of printing. Of the exhibitors in this class four were officers, and eight non-commissioned officers and privates.

(There is a photographic school in the regiment, in which all the photographs were taken by a corporal and his assistants, who were taught the art since joining the service.)

Classes 7 and 8 perhaps were most attractive to the lady visitors of the Exhibition, and if we may judge by the rapid way in which all the articles were disposed of, we need not be ashamed of the handiwork of the soldiers' wives and children. The largest, and consequently most conspicuous objects, were some beautifully worked children's dresses, some excellent shirts for the soldiers, and other specimens of useful and ornamental needlework; and so warmly was the subject of the Exhibition taken up by all classes in the regiment that the interest actually extended to the little children from four to ten years of age, and the infant school produced sufficient work to entitle it to a class for itself, and actually to cover a table of no ordinary dimensions.

In class 9, consisting of armourer's work, the armourer-serjeant exhibited (all of his own making) a breech-loading double barrelled gun, a double gun (muzzle loading), two keeper's guns, and two single barrelled guns. This artificer also worked during the time the Exhibition was open at his portable field-forge. A printing press having been set up in the regiment, it was brought to the Exhibition, and one of the drummers, assisted by a private, was kept employed in striking off copies of the *East Suffolk Gazette* (the regimental newspaper), all of which were rapidly purchased; programmes of the music performed by the band, and copies of the book of glees sung by the men of the regiment for the amusement of the visitors were also printed.

Some of the men executed very fair specimens of fret sawing during the time the Exhibition was open; and as they cut out crests and initials on paper-knives, &c., very cleverly, these articles were much in request.

Such was the Industrial Exhibition of the 12th Regiment, and if we may be permitted to draw an inference from the numerous and fashionable attendances, and the favourable opinions publicly expressed, it met with a complete and distinguished success. The number of paying visitors who attended the Exhibition were altogether 1,828, of whom 478 paid half-a-crown, and 1,350 one shilling each; there were besides great numbers of the soldiers of the garrison, all of whom were, of course, admitted free.

The expenditure consisted of the hire of the Rotunda (an expensive item, by-the-by, of £58 odd), gas, purchase of materials, car and van hire, and the profits to exhibitors, amounting altogether to £354 6*s.* 8*d.*

The receipts by admissions, sale of articles, &c., came to £309 16s. 8d.,

and the balance of £44 10s., required to meet the expenditure, was subscribed by the officers of the regiment, out of the guarantee fund.

The funds at the disposal of the committee did not admit of their awarding pecuniary prizes, and purchasing tools, as was originally intended; but certificates of merit were given to the best workmen, which were received by them with evident satisfaction, and especially by those who had previously been men of notoriously bad character, in which class were found more than one of the best artizans; and it is gratifying to know, that during the time the work of the Exhibition was in progress, and subsequent thereto, these men have been steady and well behaved; while the general amount of crime in the regiment was at the same time considerably decreased.

As a sequel to the history of the Industrial Exhibition of the 12th Regiment, I will give an extract from the *Gazette* published by that corps, which is the newspaper I have already alluded to, and which cannot fail to be heard with interest. Speaking of their industry, the editor says:—

"It is an exhibition of our industry—industry carried on in hours "that heretofore we have wasted in riot and idleness; industry that "has benefited us in health and feeling, industry that will prove to "the world at large, and to our own personal friends, that soldiers "though we be, we have not forgotten the trades and teaching of our "early life, and that we are fit for something more than 'mere food for "powder.' One of the first, and, we think, the most important features "in our Exhibition—a feature which was early impressed upon the men "of the regiment, and has been attended with the greatess success—"was that the Exhibition was open to all ranks, from the colonel to "drummer-boy, from the recruit to the veteran of nigh thirty years' "service, from the latest denizen of the cells, to the proud owner of "five good conduct stripes; to one and all was our Exhibition open; "character was to be of no account, for, indeed, it was mainly for the "sake of those of indifferent characters, and whose weakness and "natural infirmities led them into temptation, and inevitable punish-"ment and disgrace, that our present undertaking was attempted. "Many there were who were without funds to purchase the materials "for carrying out their designs, and as it would have been mistaken "kindness to afford pecuniary assistance to those whose worst enemies "were themselves, a uniform system was adopted of giving orders on "tradespeople in the city through the treasurer, by which means the "required materials were delivered to the men in barracks, thereby "saving them a long walk, and keeping the weak from temptation. "And here let us express our thanks to the tradesmen who have so "willingly assisted; to all the committee we are indebted for their "assistance; such assistance has only been made use of by a com-"paratively small portion of the exhibitors, and to those who have "worked without it no small credit is due, as many have worked "with indifferent tools, which has rendered their labours all the more "laborious. Far be it from us to disparage those who have obtained "assistance, all have worked with ready zeal; all have been animated "by the desire to uphold the credit of their regiment; and it is no

"small gratification to reflect, that limited as our time has been, in no "way has the discipline of the regiment been relaxed; on no account "has working for the Exhibition been put forward as a plea for exemp-"tion from military duties. That success has attended the Exhibition, "is now an indisputable fact; it has realised sufficient, if not more, "than will pay all expenses, and, therefore, every encouragement is "given to other regiments to have similar Exhibitions. We trust that "such will be the case, as they will repay not only the exhibitors for "their labour, but the visitors by the instruction and pleasure they "will derive from attending them."

Not long after the termination of the Exhibition of the 12th Regiment at Dublin, the following paragraph appeared in the naval and military intelligence of the *Times*, by which it will be seen, that the example shewn on that occasion, has already attracted considerable attention in other military quarters:—

"The success which has attended the Exhibition of the 12th Regi-"ment at Dublin, has induced the authorities at Aldershott to institute "a similar project, in order that the troops may have some profitable "occupation during their spare hours, as well as to afford them an "opportunity of displaying their abilities in inventing and making "articles, which will be both serviceable to the purchaser, and remu-"nerative to the maker.

"The principle object in view, however, is to lessen the amount "of crime. The project is heartily entered into by the officers, and "there is not the least doubt that it will prove quite as successful as "that at Dublin. Several meetings have been held during the present "week, at which it was decided that the officers commanding such "regiments, corps, and departments, as may be willing to take part "in the Exhibition, be the members, and form a general com-"mittee. Lieut. Gen. Sir J. L. Pennefather, K.C.B., has consented "to be president, and general officers commanding brigades Vice-"Presidents. Lieut.-Col. the Hon. H. Clifford, V.C.A.Q.M.G., Lieut.-"Col. Lennox, V.C.D.A.Q.M.G., and Major Hammersley, Director of "Gymnastics, were appointed Secretaries and Capt. Maclean, Brigade "Major 1st. Brigade, and Capt. Lockhart, D.A.A.G., Treasurers. "Every regiment taking part in the exhibition will be regulated by "a court formed among themselves, who are to make their own neces-"sary arrangements under the direction of their commanding officer, "in such a manner as he shall see fit. Each regiment will have to "find such tools as may be required by the non-commissioned officers "and men. It was also decided that if any regiment now quartered "at Aldershott, should be ordered away before the Exhibition was "opened, they should still have a right to send articles to be ex-"hibited. The privilege of making and shewing things will not be "confined to any particular class of the military, but will be open to "officers, non-commissioned officers, and men of all ranks, as well as "their wives and children. The articles proposed to be exhibited will "come under the following heads:—Painting, drawing, and pho-"tography. Carving, cabinet-making, and carpenters' work. Military "engineering, instruments, accoutrements, and equipments. Ar-

"mourer's and smiths' work. Leather-work, and needlework, and "clothwork. A space will be set apart for the exhibition of articles "collected by officers, non-commissioned officers, and men during the "course of their service in different parts of the world. The Exhi-"bition will be open in June next, and when the proceedings are "more developed, the committee will decide how long it shall re-"main open. The proceedings are sanctioned by His Royal High-"ness the Commander-in-Chief, and the Exhibition will take place in "the Club-house."

In concluding this paper, it may, perhaps, not be out of place to offer a few observations on the importance of the general application of education to the soldier, forming as it does, the grand means by which the human mind may be ennobled. Without it, we find men shrouded in ignorance which, when their passions are excited, renders them prone to, and capable of, committing any crime. Nature is, unfortunately, attended by evil as well as good propensities, and often we find the former predominate most fearfully over the latter. We need not confine our observations to any isolated class in any climate or district of the globe; evil is sure to exist everywhere, whether it be in countries enjoying the best laws and privileges, or in the resorts of savages of the most degraded and repulsive habits. But still the evil if not totally eradicated, will be greatly modified by the influence of education. We need merely to observe the grand and astonishing effects produced in our own country, where innumerable Institutes exist, pouring forth learning and improvement through a thousand streams, and diffusing their influence over the remotest regions of the world.

Now when we speak of education in its general and widest sense, we do not restrict our attention to the instruction dispensed within the walls of a college, or the information disseminated through a country by the influence of literature. Education takes a more comprehensive range, and signifies the moral culture of the mind, and a judicious application of the means best calculated to occupy our mental and physical powers, in such a manner as to be conducive to our own improvement, and make us capable of regarding the welfare of our fellow-creatures.

The man of classical erudition and nice discernment, is capable by his own exertions, of pursuing occupations agreeable to his own taste, and without which he is lost to himself and all around him. But there are other classes of the community who, in their peculiar sphere, are as indispensable to the general commonwealth as the highest and best instructed in the land.

I believe, if I have not been wrongly informed, that the scientific and amusing game of chess was originally invented by a philosopher, under the impression that he could inculcate on the mind of his emperor, who was a tyrant, the grand moral fact that his own safety depended as much upon the lowest subject in his realm, as upon those in a more exalted position; and there are few military men, being chess-players, who are not aware that the king must become check-mated by the neglect and consequent loss of the pawns.

The inference to be deduced from the above must be self-evident to all who hear me to-night. The meanest subject in our land has a position as well as the most noble and learned. In fact, were it not for the lower classes of society, what would be the value of the highest?

The main strength of a nation depends upon the mass, as the chief success of an army depends upon its subordinates. Generals may be qualified to command, plan mighty exploits, and gain splendid victories, but of what use would be their qualifications without the materials for the accomplishment of their projects?

Then does it not seem evident to all thinking men that every effort should be directed to the improvement of those upon whom so much depends? Is it not feasible to expect that they will more effectually and promptly perform their duties, when they find themselves regarded with interest and respect?

When a soldier finds himself treated with philanthropy instead of being merely placed on a footing with an automaton, he will immediately begin to respect himself, and, as a natural consequence, will esteem those whom he considers well-disposed towards him. When *this self-respect* therefore is once inspired and established in the breast of a soldier, he may be considered on the eve of a grand moral revolution, and there is no sacrifice too great for a brave man to encounter, when he finds his character at stake.

The practicability and usefulness of periodical industrial exhibitions in the army will diminish idleness by encouraging industry, they will revive and strengthen the dormant talent of the soldier, and it is hoped that they will enable him usefully to employ his leisure hours whilst in the service of his country, and, should it so happen, as unfortunately it often does, that he should through any circumstance become disqualified to perform the functions of a soldier, he can then fall back upon his former occupation, which he thus will not have neglected, or by the agency of such Exhibitions he will have acquired some trade which will thus enable him to earn his own living, and avoid the deplorable condition of being a burden to himself and all around him, or dependent upon such a pension as is totally inadequate to provide the necessaries of life.

In the event of the establishment of Regimental Industrial Exhibitions, let us hope that the objects aimed at will be fully gained, amongst which not the least important, will be the amusement and instruction of the soldier, the means of giving him useful and suitable employment during his leisure hours and the consequent decrease of crime; and thus the *morale* and efficiency of our army cannot fail to be considerably improved.

The CHAIRMAN: Though there are but few members present, I hope we shall have a discussion upon this very interesting paper, or if any gentleman has any remarks to make, we shall be very glad to hear them.

Commander COLOMB, R.N.: I cannot help regretting that my friend, Captain Bolton has not a larger audience to hear the very interesting paper which he has read to us. I am quite sure that the loss is on the side of those who have stayed away. For a naval officer to propose making any remarks upon the subject of Army Industrial Exhibitions may appear a little out of place; but I am one of those who

think nothing is out of place where one can gain knowledge: and the knowledge of dealing with men and keeping up discipline, whether it be in ships or among troops on shore, comes to very nearly the same thing in the end. Men are the same, whether they wear blue or red coats, and the mode of dealing with them must be nearly the same. So far as the subject of Industrial Exhibitions concerns the navy, there is very little to be said, because the want of space on board ship, does not allow the men to put any trade in force, and very few of our blue-jackets coming into the service as boys, know any trade or have been brought up in any. Still there are a great many other ways in which our sailors could be employed. I do not think that sufficient care is taken to employ our blue-jackets in their leisure hours. If we go round the lower deck of any of our line-of-battle ships, or iron-clad ships, we find the watch below, as a rule, asleep; and on board most ships, that is the ordinary employment of the British sailor in his watch below. It is called the necessity of the case; and it is a necessity, because I believe sufficient effort is not made to remove that necessity. When this blue-jacket, who spends his watch below asleep, gets on shore, from mere vacancy of mind he goes into the grog-shop; and the result is that his leave is broken in the morning. When I was at Devonport, I saw some efforts made in the way of supplying, or rather of filling the vacancy in the leisure hour of the blue-jacket in the shape of lectures, concerts and theatricals, and matters of that sort. In the gunnery ship at Plymouth, the *Cambridge*, they have either a play, or a concert, or some amusement that kind, I think once a fortnight. The consequence is, they really find that crime is diminished. There is no difficulty in keeping the men in a proper state of discipline. Indeed, they almost keep them themselves so, simply because their vacant hours are employed; and if their vacant hours are not employed in something intellectual, or in something above the beast, the beast will break out. I wrote to an officer of the Marine Artillery upon this subject a little time ago, knowing that something had been done there in the way of employing their leisure hours with the view of reducing crime and absenteeism. The head-quarters of the Artillery are at Fort Cumberland, about three miles from Portsmouth. The amount of absenteeism among the men was, for that reason, perfectly heart-breaking; the colonel-commanding and the officers could do nothing with it. At last they determined to give the men something to do, something to keep them employed. I will just read you an account of what has been done:—

Extract from Letter.

"I cannot at such short notice give you all the precise facts connected with the effect of the theatre, but it has now been established since November, and continues performances almost weekly—a drama and farce (new). The accommodation was so bad that only about one-third of the gunners and non-commissioned officers at head-quarters could be accommodated. The house has been full to overflowing each night, and the number of absentees more than one-third less than last year, that is, for nine men absent from tattoo, now read five or six; on theatre nights, generally 'all present.' Concerts have also been established which have raised the amusements, skittle-alleys, a billiard-table for the non-commissioned officers, a recreation-room for non-commissioned officers and men, in which bagatelle-boards, draughts and chess are at their service—are always full. This has all combined, together with a Regimental Police, to reduce the number of absentees to about one-half.

"There has not been a Regimental Court-martial held since November.

"The 'Absentee List' is confined now to a certain few men, who are irregular and always will be: if these 60 or 70 men were got rid of we should hardly ever have any defaulters at all, as the bulk of the men remain in barracks, or at all events do not go into the town in the evenings. The places of amusement are always full.

"I think from my experience, about one-third of the men (soldiers) are perfectly steady, with pursuits of their own which keep them straight, one-third are men who require to be amused and employed to keep them perfectly regular; and one-third are men of vicious and idle propensities whom nothing but fear of punishment will keep out of the defaulter's book. Now these last mentioned, have acquired habits of irregularity, as recruits, from a want of employment and amusement, and hence fall from the second to the third grade.

"Of the class of men who join us, I put down one-third of them as naturally steady from their individual characters; the other two-thirds, ordinary mortals, easily led to good or evil, and if not looked after and given something to keep them in barracks, half of these will go to the bad and become irregular men. I am sure that amusements and employments, to make barrack life more homely, would, if properly and carefully conducted, abolish the crimes of absence, drunkenness, and consequent insubordination; and the continental system with regard to garrison towns, would give a better tone to the army generally. Their mental condition would be improved in the same ratio as their physical condition. The want of attention to these two things, ruin large numbers of our men—I mean the British soldiery."

I have very little more to say. It may be thought perhaps, that this does not bear upon the point. But I think it does, because Captain Bolton at the end of his paper touched upon the general question; and the general question is the employment of the British sailor and the British soldier in his leisure-hours. I think Captain Bolton has brought forward the very best mode of employing them that I have ever heard of.

The CHAIRMAN: I quite concur in the importance of Captain Bolton's paper, and I do not think anybody could take exception to Captain Colomb's remarks, on the ground of their inapplicability. With regard to the government of men, it is most important that it should be, as other things are, reduced to a science. I am not prepared to go with Captain Colomb to the extent he does, with respect to the impossibility of organising any scheme for the employment of men in the navy. I am sure, as he has stated, and as Captain Bolton has suggested, there is a far superior way of employing their minds than by mere theatricals. Apart from any higher ground of objection, there is this simple one, that theatricals only occupy the minds of the people during the performance, except those who have to sustain the characters. Captain Bolton's plan embraces every man that chooses to come forward, which is very important. When I look back to the early days of the navy, I remember that the importance of occupying men's minds was quite recognised by the old school of officers. But their expression was, "Keep the devil out of their minds;" and the way they set about it was to put the men to underrun cables, clear hawse, and holystone decks on Sundays, leaving no resource for the week-days. It has been well said by a philosopher, who has left his mark upon his age—perhaps no more indelible mark has been left upon his age than by him—that the only way of getting rid of a wrong habit is by "the expulsive energy of a new affection." This is in some measure what has been suggested by Captain Bolton. Any gymnastics of the mind are important, particularly when they keep men engaged, fill up a vacuum, and prevent a recurrence to bad habits. Sin thought over, would find its execution; so our men break out of barracks and get out of their ships. It is more important, now that war is made a science, not to have men who are only food for powder. We must have men that are intelligent enough to use the weapons put into their hands. This is the kind of education that is desirable. Men thus trained will be not only more skilled in the use of their weapons, but they will be better qualified to provide for themselves and protect themselves against the inclemency of the weather. The manifest consequence being that they suffer very grievously, because they do not possess the most ordinary and trivial kind of information to enable them to select ground for encamping, or to form trenches to carry off the water—things that would suggest themselves at once to trained minds. I have pleasure in renewing my acquaintance with the 12th. I was very much struck with the characteristic difference between the 12th Regiment and some other regiments that I met. I took one wing of that regiment to the Cape of Good Hope in 1851, and I have a very agreeable reminiscence of the officers. Another thing which struck me was that my men at once fell into a brotherly kind of communication with the soldiers. With the men of other regiments that I have embarked, my men would not associate at all. They looked upon them as inferior people. Now, I contend it would be for the interest and for the economy of the country if the status of the soldier and sailor were raised. A higher class of men would come into the service, and you would find that a lesser number of men would do the work now required. We should have less crime. A number of the men now

spend half their life in hospital from dissipation, or under punishment, so that you have to strike off a large per centage from the effective force of the army and navy because of this. Get rid of that evil, and then you might have a smaller force and yet a more effective one. Sailors, arising out of the circumstances that they have to make their own clothes, are more skilled than soldiers are. There are some idle ones who will not do that, but pay others to do it for them. I remember some years ago we captured a slaver on the coast of Africa. We had to go down to the Cape, where, it being winter, it was very cold. All these slaves were naked, male and female. The vessel was not seaworthy; what was to be done in the matter? We must clothe them. We got the hands up, and the stuff from below; the fellows sat to work, cut up the materials, and in a very short time they made the clothes. How these poor creatures would have suffered if the men had said, "We can't do anything of the kind." What a condition they would have been in. Just this difficulty occurred in some cases in the Crimea. The men were frost-bitten, and afflicted in other ways, just for the want of a little mechanical knowledge, which, according to this proposition of Captain Bolton's, would be systematically introduced into the army. It is also an important consideration, now that we are enlisting for a short term of service—ten years' men. Men, in many instances, from the loss of a thumb, or the loss of a finger, have become disqualified for the service, and not having been brought up to a trade are thrown out of work, and have only their pension of six pence or less to live on. There is no doubt if these men were to acquire trades, or were to keep up the trades they had once learned, that they would have no difficulty in finding employment. We are much indebted; indeed the whole army and navy are indebted to Captain Bolton for this paper. I am happy to say that, notwithstanding the small number present, the paper will receive considerable currency in our Journal. The meeting will allow me to return our thanks to Captain Bolton for the interest, and for the instruction, he has afforded, and the new ideas he has conveyed by this useful paper.

Captain BOLTON: I wish to be allowed to remark that the merit of the scheme is not due to me. I was merely a willing assistant in carrying it out. The idea originated with Colonel Ponsonby, and it was worked out under his immediate supervision; therefore, the whole merit of the scheme, together with all the suggestions, properly belong to that gallant officer.

The Journal

OF THE

Royal United Service Institution.

VOL. VIII. 1864. No. XXXI.

Evening Meeting.

Monday, January 18th, 1864.

MAJOR-GENERAL F. W. HAMILTON, C.B., Vice-President Council of Military Education, in the Chair.

NAMES OF MEMBERS who joined the Institution between the 1st and 18th January, 1864.

LIFE.

Cape, H., Surgeon, Royal Artillery.

ANNUAL.

Macpherson, G. G., Lieut. Cldm. Gds., 1*l.*
Roupell, C. M., Capt. 2nd Midlx. R. Vol., 1*l.*
Cery, James, Capt. 100th Regiment, 1*l.*
Sparks, R. W., Capt. 7th Royal Fus., 1*l.*
Lock, H., Capt. 108th (Mad. Infantry), 1*l.*
Burgess, H. M., Lieut. Roy. Art., Ben., 1*l.*
Peacock, G., Esq., late R.N., 1*l.*
Cormick, Jno., Lieut.-Col. 20th Regt., 1*l.*
Legge, Hon. C. G., Ens. Rifle Brig., 1*l.*
Jennings, T. T., Paymaster R.N., 1*l.*
Manson, A. R., Col. H.M. Bom. Army, 1*l.*

SPITHEAD AND HARBOUR DEFENCE.

BY CAPTAIN H. W. TYLER, R.E., Railway Department, Board of Trade.

THE defence of harbours and roadsteads on a large scale is almost a new branch of engineering science. The degree of protection that is required in the present day against naval attacks is so different from what was sufficient only a few years ago, that we have no authorities to consult, no rules for our guidance, and but few precedents for con-

sideration. The application of steam has rendered vessels of war independent of wind and tide; and the addition of armour-plates has necessitated the employment of more powerful guns, both on board ship and in coast defences. An overwhelming naval force may now be concentrated without notice upon any given point of attack, in accordance with arrangements previously made, with almost a certainty that every vessel, from whatever station, will reach the *rendezvous* at the appointed time. It will henceforth be more easy to carry out sudden and combined attacks by sea than on land; and when military operations are conducted in the neighbourhood of great rivers, the possession of vessels of war for navigating those rivers will, as has been strikingly demonstrated in the course of the American civil war, be of paramount importance to success.

The nation has seen these tendencies, and our noble and far-sighted Premier, combining the wisdom of age with the vigour of youth, has seized the opportunity. Rising above party feelings, in opposition to some of his former adherents, and doing the work of his political opponents in a true conservative spirit, he has already effected what would have been thought impossible not many years ago. Through his influence, and with the assistance of many whom we have the honour of seeing here this evening, the country in general is, as regards its principal points, assuming a respectable condition of defence; and it is from no fault of his that this has not been done more effectually. Lord Palmerston has, himself, been a consistent advocate throughout for the defence from the sea of our chief naval arsenal and principal roadstead. If we should unfortunately be dragged into war with any great naval power during the present year, we shall have to blame his opponents in this matter only, for its hazardous condition. Strange it is, nevertheless, after all the labour and money that have been expended in other quarters, that the waters of Spithead and the harbour of Portsmouth should still be absolutely without any special and sufficient means of protection, either from direct attack or from distant bombardment. But that being so, I have thought that an evening at this Institution could hardly be better bestowed than in a discussion upon the means that are best adapted for their defence. This subject combines naval and military considerations of great importance, including on the one hand various questions as to the future of naval operations in the attack, and on the other the means generally that should be employed for the defence of coasts, harbours, and roadsteads.

I need only refer very briefly in this theatre, to the importance of Portsmouth and Spithead with reference to future operations in times of war.

The land fortifications, the harbour, the dockyard and arsenal, and the magnificent roadstead which lies between the Isle of Wight and the southern coast of England, and above all their situation, midway upon that coast, combine to form the most important strategical position which we possess. An army landing east or west of it to march on the metropolis, would be threatened by its garrison in flank, and any hostile naval expedition for disembarking in its neighbourhood would

be taken in flank in like manner by such vessels as might be available in the roadstead; and the two means of entrance and exit which it possesses—by the Needles on the west, and Spithead on the east—would enable them to operate in either direction, as might be required.

In former wars, the anchorage at Spithead was at all times a secure asylum, in which our men-of-war could take in provisions, stores, and munitions, without the delay of going into Portsmouth harbour, and in which our merchantmen could collect in convoys, and whence they could depart under escort. In future wars, this asylum will be still more required, for our magnificent fleets of ocean steamers; for a vastly greater number of larger merchantmen, whose sails whiten every sea, or whose funnels blacken every atmosphere; and for the more complicated as well as more powerful war steamers which are replacing the old liners. The sooner these can get their supplies of coals, repair damages, refix loosened bolts and armour-plates, and refit deranged machinery, the greater the number that will be always fit for service; or in other words, the greater will be the strength of our fleet. For these and other reasons,—for the safety of commercial vessels,—as a refuge for disabled men-of-war,—for rapidity of coaling, refitting, and repairing,—for taking in provisions and munitions,—for the safety of the dockyard and its stores,—for that of the stores lying at Spithead in readiness for our men-of-war,—in fine, to protect the roadstead from direct attack, and the dockyard from bombardment, at the same time that the utmost facilities are afforded for ingress and egress, —two things are required: 1stly. The entrance to Spithead must at all times be denied to an enemy. 2ndly. There ought to be no unavoidable obstruction in the way of our own or friendly vessels. It will, indeed, be of more importance to give every possible facility of ingress and egress to the different classes of vessels during war than in a time of peace. Obstructions would now cause delay only, and be in most cases of comparatively small importance; but in time of war they might render disabled vessels more liable to capture or destruction, by increasing the difficulties in the way of their reaching a place of safety; or they might prevent our own vessels from assuming the offensive with sufficient rapidity at the proper moment, or might of themselves be sources of danger.

The problem to be solved may be thus stated:—How can we best keep our enemies out, without offering obstacles to the entrance of our friends? And there is a further problem which may be advanced at the same time, though somewhat prematurely. How can we best secure the capture or destruction of any enemies' vessels which may gain an entrance by stratagem or otherwise, with the least risk to our own vessels lying in the roadstead?

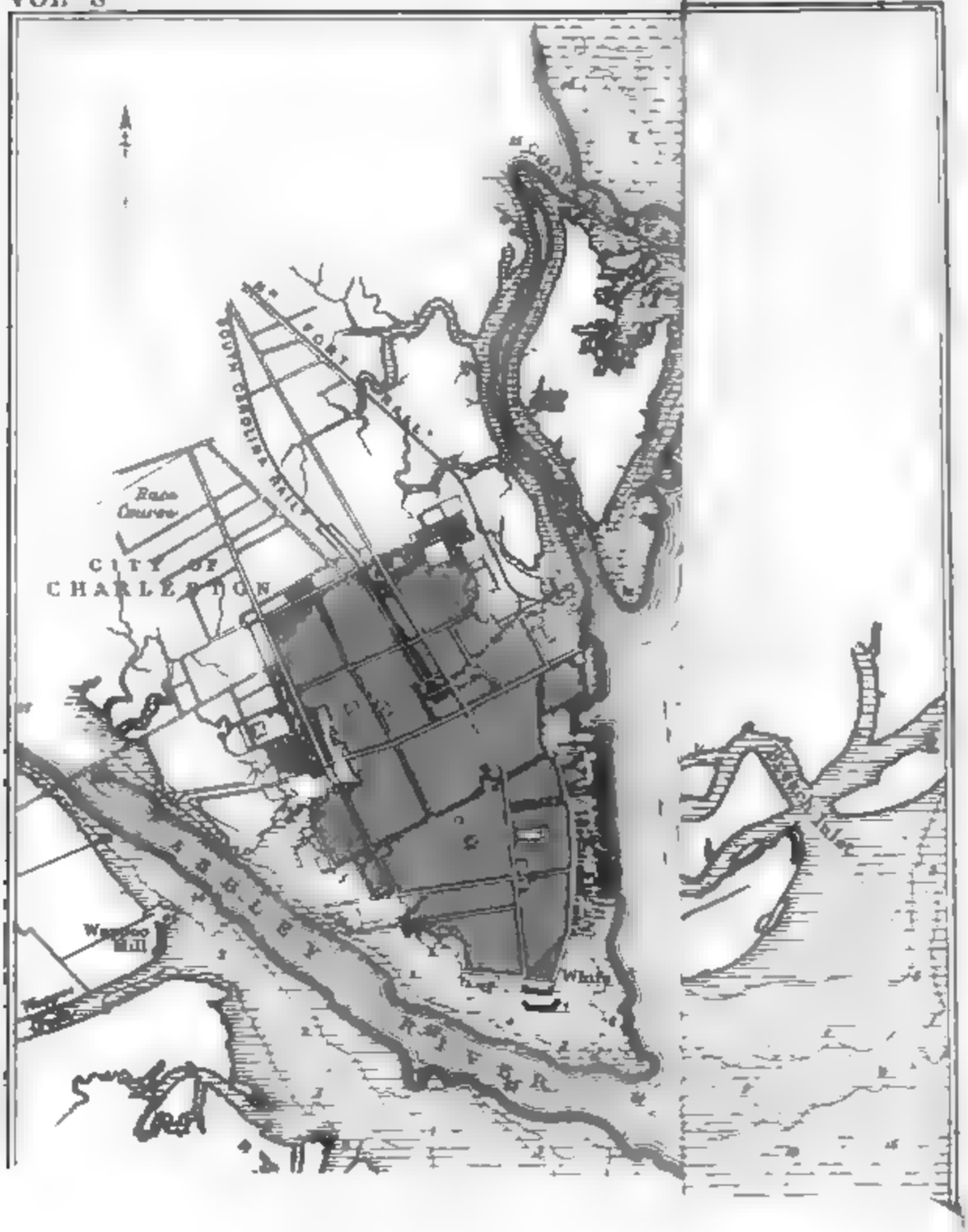
There are three passages by which a hostile fleet might attempt to force an entrance:—1stly. By the Needles' passage, the channel of which is about 1,000 yards broad near Hurst Castle. 2ndly. By the main channel into Spithead, which is about 1,200 yards wide near the Warner Light, and 1,800 yards wide opposite No-Man's-Land. 3rdly. By floating over the Horse Sand at high water, where the passage is 3,600 yards wide between the Horse Elbow Buoy and the Langston

Bar, and the same distance between the Horse Buoy and the forts on the main land. And no mode of defence can be considered to be perfect which does not provide against all these modes of attack.

There are also many means of defence applicable to different sites and different circumstances, such as—1. Forts and batteries, where foundations can be obtained for them at a cost commensurate with the object in view. 2. Obstructions more or less permanently constructed, of iron, stone, timber, or all combined, or of sunken vessels filled with stones. 3. Floating obstructions composed of vessels chained together, and armed with guns, so as to act at the same time as floating batteries. 4. Floating obstructions, of iron and timber, or supported by casks or pontoons, intended to stop an enemy by the resistance which they offer, or to delay him under the fire of batteries. 5. Floating obstructions with a net work of cords and chains, intended to foul the screws of the enemy's vessels, and thus to arrest their progress. 6. Torpedoes, or explosive machines, either fired by percussion on being struck by a vessel, or fired from a distance when the proper moment arrives. 7. Floating batteries, to act as stationary forts, where foundations for the latter cannot be obtained at reasonable cost, or where changes of position may be desirable. 8. Floating batteries with a moderate amount of mobility, capable of changing their own position during action, and of moving to attack an enemy; and, lastly, what are popularly termed steam-rams, or vessels which are specially constructed to crush the sides of the enemy's ships by blows from their beaks, at the same time that they employ heavy guns against them as opportunity offers.

These several devices are all good under certain circumstances, and have all been proposed for employment in the defence of Spithead, but they are not all equally appplicable to this particular case. Before considering them more in detail, I propose to allude briefly to the operations at Charleston, which we have all watched with so much interest during the past year.

In the chart before you (Plate XII), I have coloured with a dark blue tint (rippled in the plate) those parts of the channel, the roadstead, and the the sea outside it, which have a depth of 18 feet and upwards, and with red the forts and the city. The distance, as you will observe, from the bar (over which there is only 11 feet at low water) to the city is about 4 miles. The entrance, 1,040 yards wide at the narrowest part of the channel between Morris Island and Sullivan's Island, has been denied to a combined naval and military force for 9 months, and is still impassable to the best iron-clad steamers that the Northern Government possesses, though Morris Island is and has been for some months in Federal hands. The inner defences, Fort Johnson, Fort Ripley, Castle Pinkney, &c., have not yet been, and do not appear likely to be, called into play. The only Federal vessel that has ventured within 700 yards of the Confederate heavy guns—the Keokuk, was obliged to be withdrawn in a sinking condition, and afterwards sank from the effects of 90 of their shot. The tattered flag of Sumter still waves aloft, though the gorge-walls on the south of that fort, originally weak and exposed, have long since been pounded into brick-dust; but it still bids defiance to the utmost


Rice Course
CITY OF
CHARLESTON
Wharf
Wharf
ASHLEY
RIVER

efforts of modern artillerists. Friend and foe must alike admire the gallantry and determination with which it has been defended. The defence of so small a fort for so great a length of time, and under such a bombardment, has no parallel in history. It is said that 15,583 shots were fired at it up to November last, of which 12,302 struck, and that the flag-staff had then been shot away 34 times, but that only 27 of the garrison had been killed and 6 wounded, which involved an expenditure of 45 tons of iron and 3 tons of powder to each casualty.

We have no good authentic intelligence as to the details of the Confederate arrangements. It is said that they have constructed a framework of rough netting, attached to cables, and floated on casks, between Fort Sumter and Fort Moultrie, for entangling the screws of vessels; that they have driven piles between Forts Johnson and Sumter; and that there are other obstructions of a similar character behind this first line. We have heard occasionally of the explosion of torpedoes, and of rafts affixed to the Federal vessels as a protection against them. Certain Confederate iron-clads are reported also to have lain inside the obstructions, ready to attack any vessel which might succeed in passing them, but they do not appear to have been of a very formidable character. One of them, the "Atalanta," has since been sunk without much difficulty. The naval attack which was made on this position on the 7th of April, 1863, and from which we may draw some important lessons, was conducted as follows:—

In calm weather, which was essential to the operations of the unseaworthy vessels of the assailants, and during the spring tides, which gave an extra foot of water on the bar, nine iron-clad vessels advanced up the main channel at cable length distances. They were supported by five other gun-boats, not protected by armour, kept in reserve outside the bar, and were ordered to fire on Fort Sumter as soon as they got within range. The "Weehawken" led the way, with a raft attached to her bows, to protect her against torpedoes, and to push away other obstructions; but the raft got out of order, and the whole fleet was delayed for an hour, from 12.30 to 1.30, at some miles from the entrance, on this account. At length they were got in motion again; they rounded Morris Island, unopposed by batteries Wagner and Bee, and the defenders only opened their fire as the "Weehawken" came within range of Fort Sumter and Sullivan's Island batteries. The "Weehawken" now met with fresh disasters. The screw became entangled in the cable previously referred to, which stretches across the channel. She got in between Forts Sumter and Moultrie, followed by the other vessels. The "Ironsides," drifting with the tide, and refusing at low speed to obey her rudder, fell foul of the "Catskill," and of the "Nantucket" which followed her; and the fleet was exposed while thus in confusion to the fire of the Confederates. The "Keokuk," which had brought up the rear, advanced to within 700 yards of Fort Sumter, and was only withdrawn in a sinking condition. The remaining vessels, with their turrets jammed, or their plates pierced, or their machinery disabled, retired in time to avoid further disasters; a half-hour's engagement at the entrance of the roadstead having

proved to be a sufficient experiment. Fortunate it was for them that they did not penetrate further. They have not ventured now, in nine months more of the siege, after all the bombardment to which Sumter has since been subjected, and even with Batteries Wagner and Bee in the hands of the Federals, to make a second attempt.

The official reports which were made by the Commanders of the Monitors to Admiral Dupont immediately after the failure of the attack, and which were submitted to Congress by Secretary Welles during the past month, establish conclusively the defects of these vessels, and show that they were quite incapable of resisting the fire of the Confederate guns.

The pilot-houses were neither safe for their inmates, nor convenient for observation. The turrets and port-stoppers were damaged and jammed, and were effective only in preventing the action of the gunners, and the use of the guns that they were intended to protect. Eleven plates, each an inch thick, in the turrets, were not proof against 11-inch shot. The sides and decks of the vessels were penetrated, so as to admit the water, by shots which sometimes struck two or three in the same place. The officers of the "Passäic," the "Patapsco," the "Nantucket," the "Nahant," and the "Weehawken" (which has since gone down at her moorings), all bear somewhat similar testimony. The same mail that brought the above reports, brought also, curiously enough, the intelligence that a severe gale had seriously injured the Confederate obstructions in Charleston Harbour, and sufficiently, it was believed, to render them ineffective against the Federal fleet. But we do not hear of any renewed attack of a formidable character.

The Confederates have since the attack of April, 1863, had ample time, sufficient means, and an able Commander, and the Federal Admiral is no doubt justified in believing that any attempt to force his ships past Sumter and Moultrie, and the first line of obstructions, would be hopeless; and that such an attempt, if persisted in for a sufficient length of time, would only lead to an enormous advantage to the Confederates, in sinking or capturing the Federal squadron, and in opening the port of Charleston more freely to the blockade runners that cannot even now be altogether prevented from resorting to it.

The means which have been adopted at Charleston, of employing forts in combination with obstructions, were evidentally suitable in that particular instance, and are more or less applicable in all similar instances. They are the same that were employed successfully at Cronstadt, as well as at Sebastopol. In the former case, the Russians kept our ships outside by an obstruction constructed in shoal water, and kept their own ships in reserve, under the protection of their works; and in the latter case they sank a portion of their fleet across the mouth of their harbour. Our fleet abstained from attacking Cronstadt, and our naval attack upon Sebastopol was not attended with any great result.

But the attack on Charleston is more instructive at the present time, because it leads more directly to the consideration of the relative advantages and difficulties which present themselves in the attack, or

which are on the side of the defence, when modern means and appliances are employed. The Confederates had placed batteries in the best positions that offered, and had obstructed their channels as well as time and opportunity would permit. They had only to stand to their guns when the attack was made, and to inflict with them the utmost damage upon the enemy. The Federals had prepared a powerful fleet, from which they expected great results; but they hardly knew what they had to encounter, and they were obliged to reconnoitre (from inconvenient pilot-houses) as they proceeded, and to experimentalize, with considerable risk to their whole fleet, in their assault.

They were repulsed (1stly), because the sides of their ships were not proof against the projectiles which they encountered; (2ndly) because their turrets could not bear the test of actual service; (3rdly) because their vessels were delayed under the enemy's guns.

The first and second reasons are of importance with regard to the future construction of ships, and the size of the guns to be used in them and against them, and are obvious in their application. The third is that on which I would now lay most stress. It will have been seen how little, after all, the Confederate obstructions were required to do. Only one vessel, the "Weehawken," whose screw caught a hawser, was directly affected by them. The others were somewhat checked in their progress by the delay occasioned to the "Weehawken," and were thus thrown into partial confusion, and diverted from their original course. The "Ironsides" was not stopped by the enemy's fire, or by his obstructions, but simply by refusing to obey her rudder when caught in the tide-way. The remaining vessels were brought up, either by collision with the "Ironsides," or in consequence of the necessity for keeping them together; and half an hour's firing then completed their discomfiture.

This delay to the Federal vessels exemplifies three things which it is important to bear in mind: (1stly) the disadvantage under which an attacking fleet labours in endeavouring to force its way through between batteries or forts when any of the foremost vessels become disabled or are delayed in their progress; (2ndly.) the disadvantage of trusting to the rudder alone for the means of steerage in such an attack; (3rdly) the necessity for protecting the screws of vessels by iron casings preparatory to such an attack. And there is shown on the other hand, (1stly) the importance of checking or disabling the *foremost* vessels of any fleet attempting to force its way through an entrance of moderate width; (2ndly) the advantage of enforcing, by whatever means, a slow speed upon hostile vessels passing forts or batteries, and particularly in a tide-way; (3rdly) the advantage that may be derived from the use even of obstructions formed of cables, where the screws of the attacking vessels are exposed to their action; (4thly) the risk generally run by an attacking fleet in attempting to run past strong forts guarding the entrance to a tidal harbour, powerfully armed with heavy guns, and aided by obstructions. And it must not be forgotten that such guns as those which I may call the Big Will class, with steel projectiles, will prove as destructive to Warriors, Enterprises, and Royal

Sovereigns, as the Confederate guns did to the inferior Monitors against which they were employed.

But in applying the lessons of Charleston to the defence of Portsmouth and Spithead, we ought to form a proper estimate of the relative size and importance of the two places, as well as to understand the different conditions involved in the two problems. Charleston, however dear to the people of South Carolina, and sacred in the eyes of its inhabitants, is not a place of first-rate strategical importance. It owes its safety from land attack to the swamps which surround it, and its commerce to the swift shallow steamers that run the gauntlet of its constant guardians. In size and capabilities its harbour bears a less proportion than Southampton Water to the Solent and Spithead. The nature of the navigation, and the bar over which it is approached, account partly for the construction of the vessels that have been employed to attack it; and its narrow channels afford facilities for defence by a succession of forts and batteries, which leave no secure haven for any hostile vessel which may succeed in passing the entrance. The obstruction of those channels does not place the Confederates under any great disadvantage, or seriously impede the operations of the few vessels of a peculiar class which they wish to admit. All honour to them for the skill and success with which they have conducted their defence, and may the city continue to avoid the fate that would follow upon its capture! But it is far inferior in naval and military importance to what ought to be our own principal stronghold.

The shores of the Solent and Spithead, on the other hand, are far too extensive, and the distance between the Isle of Wight and the main land is much too great, to admit of a similar system of defence. The dark blue tint on the chart (as shown by rippling in Plate XIII) exhibits the extent of water with a depth of 30 feet and upwards at low water spring tides, and the light blue tint (shown as a dotted surface), the extent of water at lesser depths. At the Needles' entrance on the west, there is a channel comparatively long and narrow, through which the tide runs with great rapidity. This channel would not be suitable for obstructions if it were desirable on other accounts to use them, but it is capable of defence by the *succession* of forts and batteries which is in progress, and which an enemy could not pass without great risk. The entrance to Spithead on the east could not be effectually defended in this manner without constructing a number of forts in water of greater or lesser depth, inasmuch as the distances from Southsea Castle and Gillkicker Point on the north, to Nettlestone Point and Ryde on the south, are respectively 7,000 and 5,000 yards. The distance from the Warner Light on the east to the Needles' Light on the west, measured along the middle of the roadstead, is 27 miles; and it would be as impracticable to cover this vast extent of inland water by the fire of guns as it is undesirable—for the reasons already stated—to obstruct the entrance to it.

The problem, therefore, which we have to solve differs most materially from that which has been solved at Charleston. The Con-

federate engineers had a confined space to work upon, approached over shallow water and by intricate navigation, and there was nothing to prevent them from placing obstructions in positions convenient for defence, and batteries which should command the whole harbour. British engineers, naval and military, if they defend Spithead and the Solent as they are worthy of being defended, are called upon to devise some means of securing a wider and easier entrance against attack by vastly superior forces, at the same time that they leave it unobstructed to friendly vessels, and to provide the means of capture or destruction to any hostile vessels that may chance to gain admission.

In reviewing the different systems of defence that have been proposed, that of the Commissioners on National Defence, as detailed in their first able report of the 7th February, 1860, will first claim attention. They recommended in addition to the existing defences, that (1) for the immediate defence of the entrance to Portsmouth harbour, additional batteries should be erected at Southsea Castle, and a floating barrier moored across it at a time of expected attack. (2.) For defence against a landing at Portsea Island, Cumberland Fort should be fully armed, and a road should connect the works between Southsea Castle and Cumberland Fort. (3.) For defence against a landing in Stokes Bay, the rampart and wet ditch then in progress should be completed. In regard to the defence of Spithead and of the Dockyard against bombardment, they considered that (1) the Dockyard could be set on fire and almost entirely destroyed by rifled ordnance from a distance of 8,000 yards. (2.) An enemy's flotilla of small vessels, armed with rifled guns, might occupy Spithead and the Horse Sand, and might, without approaching nearer than 3,000 yards to the then existing works, bombard the Dockyard with comparative impunity. (3.) Such vessels, being continually in motion, would incur but little risk. (4.) They might by careful attention to the soundings be independent of buoys and light-ships if these were removed.

They agreed upon two points, in which we shall probably all concur (1stly), that batteries alone could not, in such a situation, be depended on for arresting the passage of steam-ships able to pass them at great speed. (2ndly.) That the enemy's vessels would not attempt to pass them unless they had an important object in view, such as the destruction of a fleet or a dockyard, or unless there was a space to be reached beyond them where they would be comparatively unmolested. And they came to the conclusion that under all the circumstances (1stly), a permanent barrier was not desirable across the Horse Sand, because (*a*) it would be costly and difficult to construct in a sufficiently substantial manner in such a locality, (*b*) it would impede the navigation of small vessels, (*c*) it might affect the form of neighbouring shoals and the channel into Portsmouth harbour; (2ndly) a boom across the channel would be practically useless without a barrier across the Horse Sand; (3rdly) "as the best means of bringing a "heavy fire to bear on every point from which the Dockyard could be "bombarded," forts should be constructed—two on the Horse Sand,

a third on the Spit Sand, a fourth on No-Man's-land, and a fifth on the Sturbridge Shoal, besides the batteries on the shore of the Isle of Wight near Nettlestone Point and Apsley House; (4thly) these proposed works, with others existing or in progress, viz., Fort Cumberland, Southsea Castle, the batteries Lumps and Eastney, Fort Monkton, the batteries on the Stokes Bay line, and that on Gillkicker Point, would effectually command the anchorage and prevent an enemy's fleet from occupying any position from which a bombardment of the Dockyard could be attempted without previously silencing two or more of the principal works.

As regards the Needles' passage, the Commissioners believed that the strong tide which runs through that channel would give great assistance to an enemy's vessels passing in with the flood, and they did not consider that any amount of fire which it would be practicable to bring to bear upon it would suffice to keep out an enemy's steamers, provided the officers in command had a sufficient object, and were determined on risking the loss which they would probably sustain in the attempt. They did not imagine either that the Solent or Southampton Water would offer adequate inducements, or that an enemy would push through to land troops for attacking the land defences of Portsmouth or the Isle of Wight, unless he had first silenced the batteries in the passage; and they came to the conclusion that if the fire directed upon it were made heavy enough to cripple an enemy's squadron, it was not likely the attempt would be made. They recommended, therefore, that batteries should be placed (1stly) on Warden Point, (2ndly) on Hatherwood Point, (3rdly) on the Needles' Point, and (4thly) that the works at Hurst Castle should be improved; and they considered that floating batteries would form a valuable auxiliary to any portion of the sea defences which might be threatened with attack.

They objected, however, to stationary floating batteries, and advocated the adoption of moveable floating batteries in the form of powerful iron-sided steam-vessels, which should be capable of maintaining a fixed station or manœuvring in a general engagement, should mount 12 to 20 guns, should have a speed of from 8 to 10 knots, and should be as light in draught as was consistent with other good qualities.

The present project for protecting Spithead from attack, and the Dockyard from bombardment, is to construct three forts, one on No-Man's-land, and another on the Horse Sand, to protect the main channel; and one on the Sturbridge Shoal to defend the interior of the roadstead; and to omit the "Intermediate" and Spit Sand Forts altogether. As these three forts alone would obviously not efficiently protect the roadstead, it is proposed also to construct large mortar batteries on the shore of the Isle of Wight, and at Southsea and Gillkicker Point on the main land, under the idea that they will command the area from which the Dockyard may be bombarded, and will be able to drop their shells into any enemies' ships that may venture inside the forts. It is further, I believe, intended to combine with these means of defence the use of moveable floating batteries,

though none are yet being prepared for the purpose, and floating obstructions.

The Needles' defences are in an advanced state of progress as far as the forts and batteries are concerned, and there is an idea, it appears, of supplementing them also, if the necessity should arise, by floating batteries moored midway in the channel, and by booms and nets stretched to stop the way, and to foul the screws of hostile vessels, under the guns of the forts.

No definite proposal appears to be yet entertained for defending the portions of the Horse Sand over which an enemy's vessels might pass at certain times of the tide, in substitution for the "Spit" and "Intermediate" forts originally proposed by the Commissioners, though the distance between the outer Horse Sand Fort and the Southsea shore is about 3,600 yards.

The reports of the Commissioners and the proposals of the Government have, as might be expected, given rise to much discussion, both in the House of Commons and by officers of both services and others elsewhere; and the warmest opponent of the Commissioners, a gallant naval officer, has more than once favoured us with his views in this theatre. In his paper of 1861, Captain Coles arrives at the conclusion that "concentration and mobility will, in his humble opinion, effect more"—I use his own words—" for the protection of England's coast and England's metropolis than any fortifications, though built of gold itself. Forts in these days of long range (which we may daily expect to increase), I consider (he says) mere *man-traps*, excellent if the object is to shut men up for the purpose of being harassed or destroyed." He gives a glowing picture also in the same paper, of the forts serving as beacons, of the enemy running through the channel at full speed alongside and among fleets of merchant-vessels laden with the wealth of the country and lying at Spithead,—of the forts being unable, in the smoke and confusion, to distinguish friend from foe, and not daring to fire from the impossibility of hitting the one without risk to the other,—of the enemy "picking up" vessels which they considered worthy of capture, and setting fire to the remainder,—and of their incidentally despatching a few ships to destroy Southampton, Osborne, Ryde, and Cowes. He does not tell us what would be the conclusion to this little morning's work, but we must suppose that in order to make good their escape they would not think it derogatory to their dignity to pass once more between the forts with all the speed that they were able to command.

Captain Coles's remedy, by which these dire results are to be avoided, is, as stated in the same pamphlet, to do away with all *sea* forts at least, and to confide in twenty iron-cased ships, and ten small ones, costing £6,000,000, possessing an average speed of twelve miles an hour, constructed expressly for coast purposes, "and ready on the first telegram of approaching hostile force to concentrate on one point." But as these vessels are to be sufficient for the defence of all the other dockyards and roadsteads, as well as Portsmouth and Spithead, and to mount guard besides along the whole assailable coast-line of Great Britain, it is difficult to understand how we are to secure

their presence at the moment they are required in any particular spot. If, on the one hand, they are scattered round the coast without any fortified harbour to resort to, they will inevitably be cut off and beaten in detail. If, on the other hand, they are to adopt the combined system of concentration and mobility which Captain Coles also advocates, they will then be necessarily moved hurriedly from point to point at a time of threatened attack, and will certainly not be within reach—as the enemy will take good care—when an attack in force is actually made. Indeed the very reason urged by Captain Coles,—that Portsmouth and Sheerness are two hundred miles and seventeen hours of steaming apart on the one side, and Portsmouth and Plymouth are a hundred and seventy-five miles and fifteen hours of steaming apart on the other, is itself conclusive against such a scheme. And on which point they are to concentrate when two admirals telegraph "approaching hostile forces" from opposite points, it would be difficult to determine. In his reply to the Commissioners' second report, also in 1861, Captain Coles changes his ground, and places the issue—not between his coast-patrol and a system of separate or individual defences—but between the mixed scheme of forts and floating batteries advocated by the Commissioners for Spithead on the one hand, and the converted vessels with a speed of seven miles an hour, which had been proposed by Sir Richard Dundas for the defence of Portsmouth only, on the other. We shall all concur, as I have said, in believing with the Commissioners that something more than the proposed forts is required for defending the roadstead; but Admiral Dundas proposed to employ the converted "old liners" to which Captain Coles refers, not as auxiliaries to, but as substitutes for the forts, because they were capable of being prepared for service with less delay and at less expense. Such vessels cannot, however, be expected to contend successfully, at all events without the assistance of the forts, against the class of vessels that are likely in future to be employed in the attack. It is clear, moreover, that forts, so far from being of less use than formerly, as Captain Coles implies, in these days of long range, become more and more formidable auxiliaries for protecting the entrance, as the range of the guns and the efficiency of the projectiles increase; and in the very unfavourable contrasts as regards the forts that Captain Coles has drawn in his second paper between forts and ships, he has omitted to state that such forts as would be constructed would have superior advantages in steadiness of platform and accuracy of fire, would never run ashore or foul of one another; could not be disabled in rudders, screws, or machinery; might carry heavier guns and heavier armour; would be far cheaper to maintain during a series of years, and would be practically in as good fighting condition at the end of an action as at the beginning of it.

The other schemes that have been proposed, have reference principally to the obstruction, rather than to the defence of the entrance to Spithead. Mr. Brooks has ably advocated in this theatre the construction of a permanent obstruction and breakwater between the Horse Elbow Buoy and the eastern entrance to Langston harbour

which would, he believes, be the means of converting into land a considerable portion of the Horse Bank, of causing an increased scour over the sea-bar of Portsmouth, and of clearing out a new channel into Langston harbour. Mr. Michael Scott has published an interesting pamphlet, in which he proposes a system of foundations to be built above water and sunk in their places. He would apply this system, not only to the forts, but also to a series of cylinders stretching across the Horse Sand. Sir John Dalrymple Hay has proposed a floating obstruction of twelve ships chained together across the main channel behind a boom, with twelve manœuvring vessels in their rear; and I hope that this scheme, coming from so eminent an officer, will meet with some attention in discussion. It would certainly appear at first sight to be a most unworthy mode of employing twenty-four of Her Majesty's ships and their crews. The ships so chained together behind a boom, would surely combine all the disadvantages of forts and stationary floating batteries without the advantages of either, and would be unable to use their broadside guns, excepting only those of the two exterior vessels while an enemy was in the act of passing them. They would be open to an attack in flank and rear across the Horse Sand, and, worse than all, the twelve manœuvring vessels behind the twelve chained vessels, and all behind the boom, would be badly placed for an attack upon the enemy at the proper moment, a situation in which I am quite sure that neither Sir John himself, nor any other British officer in command of a ship, would like to be placed.

If a boom were to be employed, it could be more effectually defended by one fort at each end of it, provided the range were moderate, than by twenty-four vessels so placed behind it. But the main argument against all these systems of obstructions, is that which I have already stated, namely, that it is still more necessary that our sea-going merchantmen, our coasting vessels, and our vessels of war, should have free access to, and a secure asylum in, these waters, during war than in time of peace.

We must also consider (independently of the above scheme) what the adoption of a complete system of obstructions, if such were employed, would really lead to. They would be required (1stly) across Portsmouth Harbour, as proposed originally by the Defence Commissioners; (2ndly) across the Horse Sand; (3rdly) across the main channel south of it; and (4thly) across the Needles' Passage. They would altogether be nearly four miles long: they must accommodate themselves to the rise and fall of the tide, and be sufficient to resist, not only the greatest storms, but also the impact of the heaviest ships at all points. Obstructions, to answer these conditions, could only be prepared at an enormous cost, and in a considerable length of time. They would be difficult to store, and expensive to maintain. The very fixing them in their places when they were required, or when war was declared, and removing them to store afterwards when they ceased to be wanted, would be an operation of great magnitude; they are not likely to be constructed while peace lasts, and I think we have only to look them in the face, and practically to consider their nature and extent, in order to determine at once that they are not the means on which

we must depend, or which are suitable, for the defence of Spithead. The application even of lighter obstructions, in the shape of net-works of chains and hawsers, would be an impediment to the navigation of our own vessels only, because they might be rendered useless in the event of a regular organised attack by the temporary addition of iron cages for the protection of the screws of those of the enemy.

Torpedoes have never yet produced all the results that have been anticipated from them, but they may no doubt be very usefully employed under some circumstances in narrow channels. In the present instance they would be dangerous as well as obstructive to our own vessels, and they are certainly not well calculated for the defence of so extensive an area.

The mortar batteries at Puckpool in the Isle of Wight, and at Fort Monkton and Southsea Castle, between three and four miles from it on the opposite coast, might, no doubt, be of some use as auxiliaries if no better means of defence could be devised. But mortars are better adapted for the bombardment of large and stationary objects, such as a dockyard or an arsenal, than for firing at moving vessels and at uncertain distances, over a range that may be counted by miles, and upon what ought to be a place of safety for our own shipping. It is surely a retrograde step in the present day, when we have got guns to carry large projectiles for similar distances, at sufficiently high angles of elevation to drop into the decks of vessels, and with greater accuracy, to adopt such an expedient; and mortars so placed can only be brought to bear upon an enemy after our own vessels have retired. One 13 lb. shell, dropped upon a vessel and exploding beneath her deck, would certainly produce a great effect, and might lead to her being sunk or captured; but a number of shells might be discharged before one vessel would be struck at a range of a mile and a half, even if they were stationary; and it would be a mere chance whether one were hit at all in a day's practice, if they were kept moving, as they certainly would be, while exposed to this or any other fire.

I need not stop to inquire whether forts are required to assist in the defence of the entrance to Spithead, because that question has now been practically decided. I presume that whatever doubts have hitherto existed as to the desirability of constructing them, have been dispelled by the performances of "Big Will," by the penetration of some of Mr. Whitworth's projectiles, and by the recent experiments with steel shot; but I think that the precise position which these forts should occupy is a question that is well worthy of further discussion. They clearly cannot be so placed as efficiently to command the whole anchorage, and still less to command the whole of the waters between Spithead and the Needles, as well as the entrance; and we must therefore seek for the best positions in which they will command the entrance, and organise some other mode of defending the interior.

The site of the proposed Sturbridge Fort is about 3,800 yards and 5,200 yards from the sites of the forts intended to be constructed on No-Man's-land and the Horse Sand, respectively, and 6,200 yards from the dockyard. The circle which I have drawn upon the chart shows the area of water which it would command at a range of 1,000

yards; and it will be observed that there is a space (marked with a dark shade) opposite the mouth of Portsmouth harbour, and 4,600 yards from the dockyard, which would be 2,300 yards from any fort or battery. It so happens also that the foundations for a fort on the Sturbridge shoal would be both difficult and costly, as it is composed of nothing but soft mud to a very great depth. Considering that it would, in combination with other works, only afford partial protection to the roadstead, and that its value in that respect will not justify a very extravagant outlay, I can come to no other conclusion than that we should do wisely in abandoning all idea of it, and in employing such forts as are constructed for the defence of the entrance only.

The proposed forts on No-Man's-land and the Horse Sand, the former at 7,600, and the latter at 6,600 yards from the dockyard, would be about 2,000 yards apart, and would undoubtedly prove a serious impediment, in combination with floating defences, to the entrance of an enemy's ships. But they are about 1,800 yards inside the narrowest part of the channel, as a glance at the portion coloured dark-blue on the chart (rippled in the plate) will show. By occupying the Warner Shoal, and the shoal opposite to it, near the buoy at the Horse Elbow, two forts might be constructed within 1,200 yards of each other, and these would have the double advantage of keeping the enemy further from the dockyard, and of commanding the main channel in a very superior manner. The Warner Shoal occupies an unmistakable position, and would probably afford good foundations for a fort; and I submit that it ought in any case to receive that which was originally intended for the Sturbridge Shoal; and there are two schemes in combination with it, both of which would be formidable and more or less satisfactory. Either the forts on the Horse Sand and No-Man's-land might be constructed as proposed, so as to form an equilateral triangle with the Warner Fort, with sides of 2,000 yards each, for the protection of this channel, or else the Warner and Horse Elbow Forts might be constructed 1,200 yards apart, with a third fort midway between the latter and the Langston Harbour Bar. The former arrangement would oblige an enemy to pass three forts instead of two in the main channel, and would more perfectly defend the shoals between the Warner Fort and the Isle of Wight. The latter would afford a closer defence to the main channel, and would protect the Horse Sand against vessels floating over it at high water. And this last is upon the whole that which I should prefer. The two forts, 1,200 yards apart, across the main channel, would be beacons, it is true, and beacons that would warn an enemy's vessels most effectually of the danger of attempting to get within 1,000 yards of them in any direction, if they made the attempt.

In combination with such a system of defence by forts, I can imagine nothing better in the way of floating defences, than six iron-clad steam-rams built expressly for the purpose, with a beak at each end, great speed, as light a draught of water as practicable, twin screws, manœuvring with the utmost rapidity, armed with the heaviest guns, each of which should be more than a match singly in these waters for any sea-going vessel. Stationed behind the forts, these rams would be ready to

make a dash, one after another, at any hostile vessels that attempted to pass them. Overwhelming them in detail as they came through, they would, by stopping the foremost ships, cause them to obstruct the passage more or less for the remainder, in reference to which operation I would recall to your memory the manner in which the Federal ships fouled each other during the attack upon Charleston. They would thus be able to retain the enemy's fleet under the fire of the forts, and prevent it from running past them at speed, which is the only means by which they could hope to succeed in getting safely through the channel.

The rams would thus form an obstruction of the best description for so wide an area, and they would be ready to co-operate with the forts wherever the enemy attempted to force a passage, either by the Needles, or by the main channel to Spithead, or over the Horse Sand, or between the Warner Fort and the Nettlestone Point battery in the Isle of Wight, though the passage at high water between the latter fort and batteries is so curved and intricate that no attack is likely to be made, or certainly to be feared, against such a system of defence, in this direction. This combination of steam-rams and forts would, I submit, effectually solve the problem which I have proposed, of keeping the enemy out without placing obstructions in the way of friendly vessels; and it would provide at the same time that defence for the inner waters which it would be impossible otherwise effectually to accomplish, against any hostile vessels which might chance to find entrance. The steam-rams would further be an admirable force for other purposes, and especially to act on the flank of any expedition against an undefended part of the coast east or west of Portsmouth; and indeed their presence at Spithead would be sufficient to prevent such an expedition from being undertaken in that immediate neighbourhood. The six rams at £250,000 each, and the three forts at £270,000 each, would cost, the former £1,500,000, and the latter £810,000, or altogether £2,310,000,—a large amount, but one which would be well expended. We should, at all events, if it were so spent, release our possible enemies from the temptation, and ourselves from the necessity, of engaging in mortar practice over the roads of Spithead.

Rear-Admiral Sir EDWARD BELCHER, C.B.: I venture to make a few remarks upon this question. In the first place, I am happy to find the engineers alive to the value of the navy. I must observe, in the outset, that with all these batteries which you propose to raise upon the Horse Shoe Sand, and other places, you are absolutely assisting the enemy by beacons. We are not to assume because we see 3½, 1¼ fathoms, and other depths marked on the chart, that that is the depth we should have with these forts, as if they were forts upon the land. There are 12½ feet more to be added at high water. The effect of building these forts would be that the tidal currents passing their tangents would cut deep channels round them, and instead of being, as now, upon the limits of No-Man's-land, and the Spit as it now stands, we should have a battery standing isolated *per se*, with a deep-water channel round it. If I was ordered to attack Portsmouth harbour, I could muzzle these forts immediately. Thus I would take eight or ten vessels; and there are gentlemen present who know that at a moment's warning we can, even at night, carry vessels through channels that were never believed to be passable, by means that we are able to adopt. We could chain vessels together, and with a flood tide allow them to drift athwart one of these forts, after setting fire to them. We could smoke the men out

of the batteries; or if we did not smoke them out, they could not see to aim the guns because of the smoke from the combustibles we could send in amongst them; therefore, I think all these forts which Captain Tyler proposes to build upon these sands are objectionable. If he could build them on a large space, at a distance from the edges of these shoals, so that the enemy could not approach them, I should not have so much objection to them; but by building them at the edge of deep water, it would enable the enemy to put, as it were, a necklace round them and smoke the garrison out. With respect to iron vessels to protect these places, I see no difficulty in building a floating battery which could be removed from point to point, and placed in position to attack the enemy wherever he may venture to anchor. You may give them 12 inches or 14 inches, or any thickness of iron you please, on the plans that I have proposed for arming batteries and arming ships with movable armour. You have only to form a cradle exterior to the vessel, and you may then add as much vertical iron as you please, plate over plate, and so render it perfectly impregnable at the water's edge. There is no necessity to build your vessels and encumber them with iron, so that they cannot move about. You can carry these shifting iron plates in-board, and when they are required for action it is very easy, by having the framework proposed outside, to put iron cylinders or plates one outside the other. In this way you can add 18 or 20 inches' protection on your floating battery. Such a battery would only be required in time of war. The vessels could be built, in the first instance, to bear a certain amount of weight on them, and the whole of that not immediately required could remain stored in Portsmouth Dockyard until it was wanted. Probably it would remain there till the day of judgment, for we should never be attacked if it was known we had such vessels available that could be armed in that way; therefore, I think a floating battery far preferable to any of these fixed batteries. Suppose an enemy smokes out these batteries, or places a blind of smoke round them, and passes in, you would at once lose the advantage of these batteries, whereas your floating batteries could move in and attack him. As to the forts at Sturbridge and on the Spit, a ship of war could pass them and take her position off Brown-down fort within pistol shot of the battery, and turn the men out. No single battery from that position would prevent any vessel from lying there and commanding every one of the works. Instead of forts it would be much better to have three or four of these floating batteries moored at Spithead. Even if the water is very shallow, you can construct vessels of small draught, and with a velocity of 12 knots, and thus move them about; whereas these forts, which cost so much, are simply beacons, which the enemy can avoid, and run past in the night. Even Captain Tyler's idea of floating batteries in support is a much better idea than that of trusting solely to the forts.

Lieutenant-Colonel COLLINSON, R.E.: Notwithstanding what has fallen from the gallant and well-known officer who has just spoken, I will venture to give an opinion that in putting a fort upon a shoal in such positions as those designated at Spithead, I do not think it will follow as an absolute necessity that it would cause such an alteration in the depth of the water round the fort as to lead to the effect which the gallant officer supposed. In the first place, it has not been proposed by anybody, at least it is not an absolute necessity of the proposition, that the forts should be put so close to the deep-water channel as to cause an immediate doubt upon that point. Secondly, if it was necessary to put them so close to deep water, it would be quite possible by addition to their foundation to cause such an impediment to the progress of the current round them, that it would absolutely tend to form a bar or shoal, instead of forming a deep channel, acting more in the character of breakwater and groins. They would naturally form a shoal round themselves, and so create a difficulty to the access of vessels to them. Then, again, I think the expedient proposed for blinding these forts and destroying their fire by smoke must be looked upon rather in the light of a temporary and casual expedient than as a regular mode of warfare for meeting a regular defence. It is one of those things which might possibly succeed in the case of an attack, but which also might very likely fail owing to some chance, mismanagement, or fault, such as occurred in the attack on Charleston harbour. I was also sorry to perceive by these remarks that there still lingers among some officers an idea that engineers entertain a strong feeling upon the subject of forts, as if it were a matter of dispute

between forts and ships. As far as I am aware, in all the discussions upon the subject connected with the defences of Great Britain, I do not think the engineers have put the question forward in that light at all, or have ever suggested that it should be placed in such a small compass as an argument between forts and ships, or between army and navy. I am sure the engineers and the whole army feel that the main defence of Great Britain must rest upon the navy. (Hear, hear.) Their only desire is to increase and assist the efficiency of the navy by providing such a permanent defence for our great sea arsenals that the navy may be enabled to employ itself more effectually at sea in its more legitimate sphere of action. Captain Tyler has shown us very clearly indeed the importance of forts in contributing to that object. The little *resumé* he has given us of the defences of Charleston has increased that opinion in my mind very strongly. Notwithstanding all the improvements that have been made in rifles, in rifled guns, and in armour plating, there still remain some great principles in sea defences, which probably will always remain so long as we use gunpowder for attack and defence. In land defences and sea forts you can always have a secure foundation for a fixed battery, from which you can get better practice, a thicker wall, whether of iron or whatever other material may be used, than you can use on the side of a ship, and a heavier gun with a longer range. Those are advantages which will always remain on the side of land defences. On the other hand, whatever the size of the ship, whatever its coating, or whatever its gun, there will always remain that inequality with regard to accuracy of fire, owing to the action of the water and the difficulty of moving a ship in the water on account of the tides and currents. Then there is the difficulty of fouling and the liability to accident to a greater extent than in the land battery. At all events, I hope for the future, after this paper, it will be understood that engineers wish to consider the defence of Spithead as a combined question of land and sea defences, of forts and ships, and not a mere rivalry between the two.

Captain FISHBOURNE, R.N., C.B.: As a naval officer I should be very glad to accept Colonel Collinson's proposition, and all naval officers should concur that there ought to be no difference amongst us, except the jealousy who should do his duty best. With regard to the plan suggested by Captain Tyler, I must confess that I have always entertained the same view which has been put forward by Mr. Brookes, that it would be desirable to have a line of defence in the direction of Langston harbour carried across the flat. I do not think it would offer any material impediment to trade; and I am sure it would be a great advantage for the purpose alluded to by Captain Tyler—the facility which it would afford for the repair of vessels. These vessels have to take out their gunpowder and a great deal of their stores before they can go into Portsmouth harbour; and with every increase in the size of ships that difficulty will be increased. The proposed plan would make an excellent harbour where vessels could repair; every facility would be afforded behind the barrier that would be run across from Langston harbour to one of these forts that are now building. I quite subscribe to the view put forward by Captain Tyler and Colonel Collinson; and perhaps I would be inclined to extend it a little more—that the progress of artillery has been, and will continue to be, more and more in favour of forts—arising out of the circumstances that any advantage which ships have hitherto had against batteries has been from their power of concentration of fire. By having two or three decks they have brought an immense number of guns to bear upon a few guns in return from a fort. The application of iron coating to ships has brought ships to one deck, and very few guns on that. Therefore the former disparity has altogether vanished. Another point has been brought out—long range. Now long range is of no value on board ship, for the want of steadiness of platform. A necessary condition of long range is a slow moving projectile, and a high trajectory. The consequence is that every infinitesimal motion which there is on board ship renders anything like certainty of fire from long range on board ship impossible of attainment. The descending angle is very great; there is no ricochet, the shot plumps in, the narrow deck of the vessel to hit. If you want to hit a distant object at all, you must have absolute steadiness. Whatever nicety of arrangement you have in the gun, all vanishes the moment you embark it on board ship. Long range from ships I contend is nonsense. One gun may be all very well for the occasional

circumstances in which ships are placed in smooth water, up harbours, where it is desirable to reach into a battery or into a dockyard, or where you have a large space to throw shells into, then it is of advantage. But in that case it should be a class of gun which would admit the use of spherical shot. For the ordinary service of a ship's gun, the shot ought to be round. Looking at the general question of fortification from a broad point of view, my idea is, that in acting upon the defensive, we are giving up our character, whether it is individually or nationally; that the true art of defence is effective offence; and I believe that is more consistent with our national character, and that no nation can so effectively carry out that principle as our own. It appears to me a proclamation of weakness the moment we begin to act upon the defensive. It is a feeling that will have a very strong influence upon other nations: when we begin to act upon the defensive, they will begin to think we "funk" and that is the very last thing we should encourage the idea of.

Sir EDWARD BELCHER: I just wish to make one observation; fact is better than theory. Hitherto in action our ships of war with mortars on board have done their work very well. Take the case of the "Etna," against Patras, which made the attack in a gale of wind. Again at the siege of Gäeta for 13 weeks we discharged every gun and mortar from floating* batteries; we had no land batteries bearing on the sea-faces; and we threw our shells with the utmost precision, even into houses suddenly designated. If we cannot fight at sea, or if the enemy cannot do, as we can do, in attacking Portsmouth, why care about Portsmouth? for, from what is stated, they would not be able to hit it.

Captain TYLER: I need not detain you at any length in replying to the gallant officer who spoke first. He is afraid of these forts acting as beacons. I thought I had pretty well disposed of that question when I said the forts would be rather beacons of warning than beacons of safety. But independently of forts there are already beacons enough. There is no difficulty in any foreign vessel finding its way into Portsmouth harbour. There are beacons on Portsdown Hill, beacons at Gillkicker Point, beacons over the whole harbour; and as the Commissioners state, if the buoys and lights were removed, the enemy's vessels would have no difficulty in finding their way in by the soundings. With regard to the question of smoke, the gallant officer proposed instead of forts to moor floating batteries in their places. I do not see myself why the smoke should take more effect upon forts than it would upon floating batteries.

Sir EDWARD BELCHER: Not to moor them; to anchor them *pro tempore* where required. *They* can *move* to another part when the smoke vessels arrive.

Captain TYLER: Then when the smoke arrives the vessels are to run away from it, so that the difficulty will be very easily overcome; the enemy will have nothing to do but to bring out a few smoke-pots and these vessels will turn tail.

Sir EDWARD BELCHER: Divide right and left, and get out of the way of it; avoid them.

Captain TYLER: That objection is one that will not apply as regards forts: the forts will not be driven away by smoke. If the smoke does come, and that will depend upon the way in which the wind blows, the forts will do their best to fire through it; and if a stiff breeze should be blowing, the smoke will not remain long.†

The CHAIRMAN: It remains for me to thank Captain Tyler for the able paper he has read.

* None exceeding 200 tons. Twenty-six mortar vessels, carrying 10 inch and 13 inch mortars. Thirty-six gunboats, carrying 68-, 32-, and 24-pounders.

† The Federals have not yet smoked the garrison out of Fort Sumter. Any attack in which smoke is depended upon is liable to end in smoke.—H.W.T.

LECTURE.

Friday, February 19th, 1864.

Colonel P. J. YORKE, F.R.S., in the Chair.

THE ERRORS OF THE RIFLE.

By Captain G. B. V. ARBUCKLE, late 57th Regt.

IN offering some remarks on the errors of the rifle, I wish to say, that the observations about to be made and the points touched upon, which may improve the scores in general both of the soldier and the volunteer army, are offered to your notice for this reason, chiefly, that they do not appear in any printed form. There are some to whom my remarks will not be new, viz., the old steady and practised hands, but there are many young aspirants for honours at Wimbledon and elsewhere to whom they will be new; and although I obtained a certificate of the first class at Hythe, it is not on that account I would venture to put forward my opinion, but there are some points hitherto not touched upon, which I hope will appear worthy of consideration.

The points I shall remark chiefly upon are these:—1st. How it happens that the champion shot of one year seldom stands A 1 on the list another year. 2ndly. The importance of calculating very minute or decimal errors.

If shooting were a mechanical operation, it would be perfect. The rifle would be (as it often is now) perfect, the rest from which it is fired would be perfect, on a perfect foundation,* &c.; as all this cannot be, it is endeavoured to make it as nearly approaching a mechanical operation as possible, for which reason the importance of position drill is so much insisted on.

The fault, then, may be of two kinds—

When the rifle is correct,
When the rifle is incorrect.

In the first case, if the rifle is correct, the fault of a bad score must

* When Her Majesty the Queen fired the first shot at Wimbledon the trajectory was not allowed to depart from the bull's-eye, but the rifle required constant watching, as the platform sank gradually with the weight upon it, although so little.—G. B. V. A.

rest with the rifleman. In the second case, the errors will be ascribed to the rifle, and will continue to manifest themselves until the rifle is corrected, but these cases are so rare that it would be as well to confine our observations to the first case; when the rifle is correct. When it is so, it is surprising what a number of points must be attended to, in order to ensure accuracy, and, indeed, unless they are attended to with the utmost care, inaccurate shooting will follow as a positive certainty; these items, on a moderate scale, amount to fifteen at least, and unless all of them are guarded against, no good shooting ought to be expected.

It is for this reason, viz., the difficulty of attending to *all* the minutiæ, that no one man, however good one day, is found as a matter of certainty, good the next.

It MAY be so, and if the operation were mechanical, it would be so; but we have only to look to the Wimbledon reports, to see how uncertain rifle-shooting at present is. We there find Mr. A., who won the first prize of 250*l.* and the gold medal at one time, enters for other prizes and is third or fourth. The champion of one year, makes a very poor figure the next; the winner of prizes one day, makes very indifferent shooting the next.

Mr. B. wins a magnificent cup at one range, and on the *same* day, with the *same* rifle perhaps, comes in 5th or 6th in another match at another range; in short, as to certainty there is nothing like it. It is true you may pick a group of good shots, and they can be depended on to make much better practice than another group not so selected; but of the first lot—the group of very good shots—the *crême de la crême*—take for the sake of argument the eight best shots of England, and that a stranger looks over the score: One is first—one last, and between the two what a variety of comparisons may be made, and yet they are all good. If the first should be accounted very good, and the last very bad, a stranger might class them as follows:—

1. Very good shooting.
2. Good.
3. Verging to good.
4. Tolerably good.
5. Verging to bad.
6. Indifferent.
7. Bad.
8. Very bad.

In the same manner if the eight best shots of Scotland are taken. The first may be reckoned the best, and the last of the eight the worst.

and yet these 16 have done wonders with the rifle, being, indeed, the champion 8 of the two countries. But if the same eights were to shoot in a week following at the same range, under circumstances identically the same, the last would possibly be first, and the first last; or if this should NOT be the case, then the first would not remain first, nor would the second remain second, nor the third third, but places would inevitably change, and so on to the end of the chapter. Why, then, is this so? Unquestionably because of the almost insuperable difficulty of getting all things right at the right moment.

Let us consider, then, how many things are to be got right, without

which it is hopeless to make a good score, and then, if it is in the power of the rifleman to have them all in good order.

First of all we will assume the rifle is correct, then as the

1st necessity.—It is undoubted that the quantity of powder for each charge must be the same, for if too much, it will throw the ball too far; if too little, too short; thus the 100th part is sufficient to do this at a long range.

2nd.—The powder must be of the same strength; it should be weighed by the person firing himself, and from a large quantity well mixed, so as to ensure uniformity.

3rd.—If the first two are attended to "then," it must be kept dry, for dampness weakens it. The necessity of this will be shown, when the decimals of error are considered. Here, then, are three points connected with powder to begin with.

4th.—The bullet must be the same weight; for if too heavy, it will fall short, if too light, will be propelled too far. (The charge being always the same).

5th.—It must be compressed, not cast. Every bullet that is cast has a hollow in it, caused by the contraction of the metal. All metal, whether a bullet of lead weighing ½ oz., or a crank of iron of 50 tons, if cast, has a hollow in the centre, caused by the contraction of the metal, which nothing can prevent.

6th.—The grease used is of importance, and ought not to be of an oily nature, for if so, it wets the powder, and *so* weakens the charge.

7th.—The wind must be most carefully considered, for if blowing straight against the rifleman, it retards the flight, and the rifle will require more elevation; if towards the target it augments the flight, and less elevation is required. If the wind is from the right, it will throw the ball to the left, if from the left *vice versâ;* but if this only had to be considered, it would be little indeed. There is *every variety* of the above, and then allowing this, there is every change of distance. What is allowed for 500 yards will not do at all for 600, and unless the wind is most carefully attended to, it is useless to expect good practice; indeed, while shooting ordinarily, as at Wimbledon, the flag must be watched, to show the force of the wind at different times, even of the same day. These, then, are some of the difficulties of rifle shooting; but it may be said are there more? I fear the list enumerated is only a part. If the rifle is correct as a 7th necessity, it must be held with sights perpendicular. If it is so, it must be pointed exactly correct, the 8th point to be attended to.

Allowing it is a different matter to have all the above items kept in view, and having them so, unless the following are attended to also, the rifleman may as well stay at home, and better if he has to pay for entries.

9th. The eye must be correct—Firing from a rest, and having hit the target three times in succession, the fourth shot strikes just on the edge of the target, and 3 feet from the centre to the right—(it will be granted such an error often occurs)—all the circum-

stances being the same, powder, bullet, &c., an error of the eye must be the cause; the fore-sight was pointed to the right, and hence the bullet struck to the right. The question is *how much* was the fore-sight pointed to the right or in error? If the distance was 500 yards, it will be found by calculation the sight was pointed $\frac{12}{1000}$, say $\frac{7}{100}$ of an inch in error. In like manner if the fore-sight was pointed $\frac{7}{100}$ of an inch to the left of the centre, the bullet would strike 3 feet to the left; if $\frac{7}{100}$ too high, it would carry 3 feet too high. If the distance were 1,000 yards, and the error 3 feet, then the error at the time of firing would be half the above, or $\frac{36}{1000}$ inch. The larger quantity $\frac{7}{100}$ is very small; how much smaller the half of it. For this reason the sights should be regulated according to the eye of the observer, and as fine as the rifleman's eye-sight will permit. These quantities, the $\frac{7}{100}$ of an inch, and the $\frac{36}{1000}$, although so very slight, need not discourage any aspirant for rifle honours, for although small, the eye is capable of appreciating and regulating them too. One distinguished officer of volunteers struck the bull's-eye 18 times out of 20 successive shots. Here all the items having been carefully attended to, as shown by the result, the whole would have been useless, had not the eye been perfect also; indeed its delicacy is marvellous, and its accuracy almost incomprehensible, save when we consider Whose handiwork it is.

10th. Uniformity of bullet must be preserved.—It will be observed that the top of the bullet is of a uniform shape. This is in order that the resistance may be uniform. This uniformity must be retained when the bullet is rammed home; it is manifest, therefore, that it must not be struck with the ramrod, but gently pressed into its place in the barrel, pressed quite home, so that no space be left between it and the powder.

11th. At least five minutes should elapse after firing before loading again, for this reason, the last discharge has heated the barrel, that heat keeps the grease more liquid than when cool; if liquid the powder gets damp, and, therefore, weaker.

12th. A most prominent cause of error, and one which spoils many a man's good score, is the want of a proper position. At Hythe I observed an excellent shot, in the same squad as myself, hit the target 20 times in succession at 500 and 600 yards, and not count a single point. Every shot was a ricochet. Watching carefully, I found out his error and corrected it. His left arm was not kept

The error at any distance may be found thus, putting the error at $\frac{1}{10}$th of an inch, and the range 500 yards, if to the right or left, elevation or depression,

As the distance from the eye to the fore-sight pointed wrong, or $\frac{1}{10}$ in error,—say 3 feet or one yard is to its error $\frac{1}{10}''$—so is 500 yards to its error, or,

1 yard : $\frac{1}{10}$ inch : : 500 yards : 50 inch or 4 feet 2 inches.

If 1,000 yards, and the error $\frac{1}{10}$, then

1 yard : $\frac{1}{10}$ inch : : 1,000 yards : 100 inches, or 8 feet 4 inches.—

G. B. V. A.

perpendicular to the knee; if it is so, and held firmly, the muzzle cannot fall at the explosion, but if the arm is at an angle it is bent downwards by the kick of the gun, which it cannot be in the first case. Being bent down *ever so little*, as I showed, by the decimal error, the ball will almost invariably ricochet. A familiar instance, illustrating what I mean, is this:—If two ramrods are placed perpendicularly, one on the top of the other, and kept so, they would support a considerable weight; but if the least out of the perpendicular, they would support no weight; so, if the arm is really perpendicular it cannot be compressed, but if not, it is invariably bent downwards, as shown practically, though not felt by the rifleman firing.

13th. The rifle, it need hardly be stated, must be kept clean; if fastened to the stock with bands as the Enfield, these bands must be carefully screwed, for if too tight they compress the bullet, retarding its flight and causing ricochets,

14th. The pull of the trigger is important and should be as light as possible, consistent with safety—6 lbs.-pressure has been considered by the military authorities as affording these advantages. That may be necessary for private soldiers, but it is far too great for people in general; it is said a less pressure is dangerous, but so is gunpowder and everything connected with it; a light pull simply requires greater care.

It would be greatly to the advantage of riflemen if a less pull of trigger and also a rest for the rifle were allowed. It is to be hoped that many years will not pass before rests will be granted. They are simple, easily carried, not expensive, and of the greatest use. With our small army, efficacy is the one great thing to look to.

Without venturing a political opinion as to Denmark, had circumstances obliged us to send an army thither, it *must* have been a very small army indeed, compared with that of Austria or Prussia—of great consequence then, that the men composing it should have been as efficient as possible.

At present the great delay in firing is all caused by the difficulty of getting a proper alignment; with a rest it is obtained immediately at all kneeling distances, therefore a *very great* amount of time would be saved—a most important item; an indifferent shot who misses the target 15 times out of 20 at 400 yards without a rest, will hit it 15 times out of 20 with a rest. There is no difficulty about the matter, and the improvement it would effect in the shooting would be very great. Ramrods that could be used as rests, might be attached to every Enfield rifle now in the service at a cost of 1*s*. each.

This suggestion has been approved of by rifle instructors in the regular army, and feeling perfectly confident of its usefulness, having seen it tried, I trust others will try it also, so that the subject may be, to use an expressive modern term, well ventilated; in a few years it may be considered worth attention, and in a few more perhaps adopted. The good shooting in the returns of our army would be increased from 50 to cent. per cent. I am obliged to mention years, as history shows the above statement regarding the slowness to

adopt improvements to be true; one of the most useful reforms, viz., that from flint locks, with the troublesome powder-horn, &c., to percussion caps, took no less than 27 years to accomplish. With continental armies, so vastly superior to ours in numbers, this *little* island should have its *little* army as perfect as circumstances will allow. It is also the greatest humanity to make weapons of war as deadly as they can be made, for, although paradoxical, it is yet true that the more deadly the weapons used in war, the less is the loss of life. That this is true we have only to look to history: at the battle of Flodden, on the Scottish side only, the king and 10,000 men were left dead. At Waterloo, where gunpowder was used, the loss of the whole allied army was less than 8,000 in killed and wounded. Although numbers must of necessity have a great bearing on the question, it is also a question of spirit, and that spirit must be inspired by the confidence of men in their leaders, and that confidence must be inspired by the perfectness of the details of an army in all parts. What I mean is this, if numbers were to be considered the chief necessity, then it would only be necessary to bring 200,000 of one nation to conquer 100,000 of another; we know this not to be the case, but as we have not got men, the endeavour must be to make up for the quantity by the quality.

At the annual matches at Wimbledon a gradual process of sifting goes on, the residuum being a few winners only. Of the immense numbers who compete, those who appear are the best from many localities, indeed everywhere that a volunteer corps exists. Of the 250,000 volunteers, each corps sends forward those men who have proved themselves the best shots in their own neighbourhood, so that Wimbledon may be said to represent the *élite* of the riflemen of the day. And of them, how many go back empty, any one may see by referring to the report of the proceedings at the meetings. The reason undoubtedly is, not the carelessness of individuals, but their not being acquainted with all the minute details necessary for success. If it should be said, there are 50 prizes and 250 men to compete, therefore 200 must be losers, that is true; but as to the winners, they are not 50 of the 250, but 40 or less, some men taking two, three, and four prizes. My endeavour in this paper is, to impress upon riflemen generally the importance of *little* details, without which *great* results can never be obtained; and in summing up the different points, probably no one will be found to dispute this. That although a prize *may* be won without their being alluded to, still every one competing ought to bear in mind:

1. That the powder ought to be of the same weight.
2. Weighed from a large quantity to insure uniformity.
3. Must be kept dry.
4. Bullet of the same weight.
5. Compressed, not cast; as all cast bullets are eccentric in their flight.
6. Grease of suitable nature.
7. Proper allowance for wind.

8. Rifle must be held with sights perpendicular.
9. Correct alignment.
10. Bullet pressed home, not struck with ramrod.
11. Not to load when the barrel is heated.
12. Proper position, forearm to be perpendicular to knee.
13. With Government rifles to see the bands are not too tightly screwed.
14. Pull of trigger to be as light as allowed by regulation.
15. Never fire unless you can snap a cap without the least motion, except of the finger (and the eye steadily fixed on the mark); if you cannot do this you are not in good shooting order.

Having only graduated to a certain extent, there may be points of equal moment not touched upon, and the Institution will be glad if any one would point them out. Having felt the importance of this knowledge, particularly that of decimal errors, and their having been pointed out, it will give me much pleasure to hear that the subject engages attention.

LECTURE.

Friday, March 4th, 1864.

COLONEL P. J. YORKE, F.R.S., in the Chair.

THE APPLICATION OF ELECTRIC TELEGRAPHY TO THE STEERING AND GENERAL MANAGEMENT OF A MAN-OF-WAR.

By Lieutenant A. H. GILMORE, R.N.

THE object I have in reading this paper before the members of this Institution, is to explain the construction, action and application, of the electric telegraph to the working of a ship. If in the course of my explanation, which is written for my practical, and not my scientific hearers, I should touch too much upon the first principles of electricity, and enter a little into detail, I trust those present who are better acquainted with the science, will forgive me if my lecture prove a little tedious.

It is now some seven years since my late brother brought to the notice of the Admiralty, the means of applying electricity to conveying the necessary orders from forward to the helmsman in dark, windy nights, when navigating narrow intricate channels; and submitted to their Lordships an electric dial for that purpose. This dial had been used on board the "Wonga Wonga," in Australia, and had proved of infinite service on many occasions. After the lapse of some years, and after my brother's decease, their Lordships allowed my partner and myself to fit our steering apparatus to Her Majesty's ship "Resistance." In 1862, we fitted to that ship the very dial that had been used in the years 1856–57, and which, since then, had been held in reserve, ready for the day when the order should arrive for it to be fitted to one of Her Majesty's ships. That order did arrive; and that very dial, with certain alterations and improvements, was at last fairly launched on board a man-of-war. There is an old saying, "Keep a thing seven years, and a use is sure to turn up for it." We have here the verification of that old saw.

Their Lordships were informed, that although this individual instrument was only applied to steering purposes, still a further application of the same means would enable us to communicate to any part of a ship with which it would be necessary for the captain to have immediate and unerring communication.

I see here many naval officers; to them it will be unnecessary to describe the difficulty that exists in conveying at night, in a gale of wind, or even in a strong breeze, or when steam is blowing off, an order by word of mouth from the fore-bridge to the wheel. In long ships it is necessary to place men at intervals on the deck, to pass the word along. The eddy winds about the deck whisk the words away from the speakers' mouths, and the order frequently arrives at its destination mutilated, or is lost altogether, and has to be repeated. Such mistake of an order might have caused irreparable mischief and loss of life. The time lost, whilst the order was being repeated, might have just been of a sufficient interval for mischief to occur, and "too late, too late" would be the reply, when, alas! the order itself had arrived too late. Any sailor, and many travellers can call to recollection the close shaves they have seen, from the helm not being "given" in time; or from the order having been misunderstood, the wheel having first been put the wrong way, and afterwards having to be put right in a moment of emergency. Take the following for instance—the night is dark and full of gloom, the gale is whistling through the rigging, the sea is dashing against the side in crested waves; the range of sight is limited to a few fathoms, and the range of the voice to a few feet; when towering on your weather quarter a huge mass tearing before the gale, emerges from the gloom, bearing down upon you with all the force of destruction; "hard up," is the order shouted, and if luckily the order is heard and acted on, the stranger flies past you, and the heart that had been in your mouth settles fluttering down into its accustomed place. But if the order had not been understood, what then? Look to the wreck chart, or read the list of missing vessels, or even the cases of collision tried in the Court of Admiralty. Imagine another case: you are running up channel before a south-wester, the look-out man cries "A light a-head," you see a small vessel—a fishing smack crossing your bows; put your helm over at once, and you clear her. The helm must be put over immediately or you are upon her, and every soul in the little craft will be lost; your heart again beats tumultuously with fear for those poor fishermen. If the order is not instantly acted on, or if it be misunderstood, a watery grave *must* be their lot.

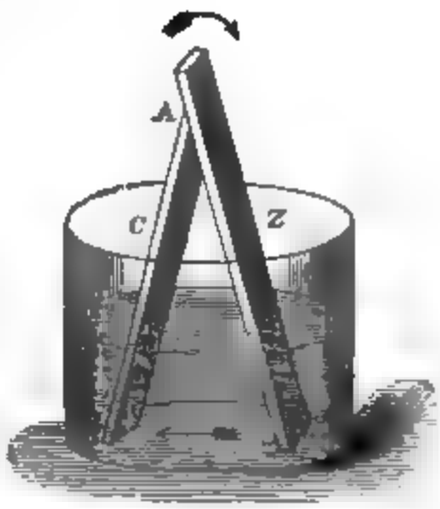
It is needless to multiply cases in which a moment's hesitation or a single error would be fatal, especially in fleet sailing. It *cannot* be denied that in the present condition of naval warfare, a means of instantaneously transmitting orders from one part of a ship to another, is imperatively demanded. Rapid, consequently successful manœuvres, can only be carried out by rapid and correct transmission of orders, and their equally rapid obeyance. If ships are to be used as rams, it is imperative that in giving collision, the ram be steered to a nicety, and her course altered instantaneously. If also, as Admiral Sir G.

Sartorius proposes, large guns are to be put into small vessels—these vessels, forming as it were, locomotive gun carriages—the elevation and depression of the guns being obtained by elevating screws or quoins, whilst the training of the guns is to be effected by the horizontal movement of the vessel's bows to port or starboard; how necessary that the training should be gained with the utmost rapidity, so as to cover objects in motion. The double screw is a great step towards this end, but even the double screw is useless, unless we possess some means of instantly sending the proper orders to the engineers. Also in manœuvring ships, a means of communication is essential, not only between the captain and the helmsman and engineers, but equally between him and the cupolas, divisions of quarters and magazines; so that, when the order is given to the helmsman to alter the helm, instructions would be sent to the engine-room requiring the engines to co-operate in the movement; to the officers in charge of cupolas to train the cupolas as the ship comes round; to the officers of broadside batteries to lay their guns on the requisite bearing; and to the magazines to order the most destructive charge suited for the time to be passed up.

The particular telegraph I am about to describe is applied primarily only to steering purposes; but I have here a ground plan of the key-plates of a larger telegraph, by means of which the officer in command is in communication with wheel, engine-rooms, cupolas, or divisions of quarters and magazines. The principle contained in each instrument being nearly the same, a description of one will lead to a thorough comprehension of the whole. The electricity employed in this apparatus is commonly termed voltaic electricity, and is the production of the action of a galvanic battery.

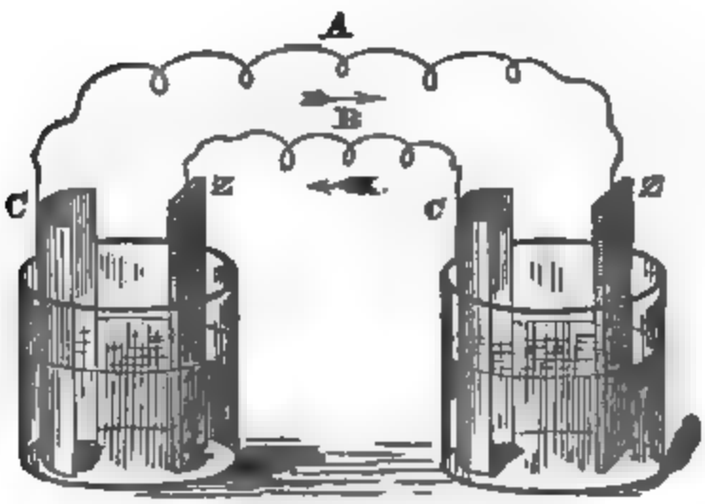
If we take a piece of zinc Z (Fig. 1), and a piece of copper C, and place them in water, so that the submerged parts shall be separated, whilst the upper parts rest against each other, we have a simple battery. The oxygen of the water attacks the zinc, chemical decomposition takes place, and a current of electricity is generated. This will continue as long as the upper parts of the metals are in contact or connected, but the moment they are separated, all action ceases. Of course such a battery as this is very weak, the zinc becomes coated with oxide of zinc, which being insoluble in water, stops all chemical action. A little sulphuric acid added to the water, however, obviates this by turning the oxide of zinc into sulphate of zinc, which being soluble in water allows the chemical action to continue. As long, therefore, as there is any zinc to be acted on and eaten away, and any sulphuric acid to combine with the oxide formed, a current will continue until the solution becomes saturated with sulphate of zinc, when, by a pecu-

Fig. 1.



liar electrical process, the metal zinc becomes deposited on the copper, and stops further action. To obviate this, it is usual to place the zinc in a solution of sulphate of zinc, and the copper in a solution of sulphate of copper, separating the two by a porous earthenware partition, when copper is deposited on the copper plate, which of course does not interfere with the generation of electricity. Such a battery with only a pair of plates, is of course only of small power, and can only work through a short distance, any addition to the length of the connecting wire A (or conduit pipe) tends to reduce the power, but, on the other hand, by increasing the number of cells we can make a battery of sufficient power for any required purpose.

Fig. 2.



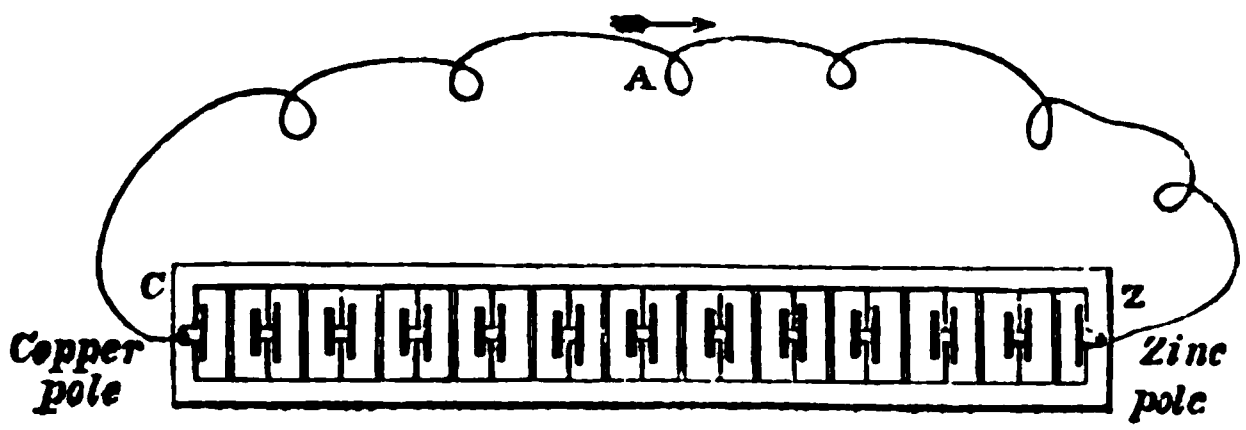
Let us take two vessels similar to that in Fig. 1, and charge them similarly, but instead of leaning the metals against each other, connect the zinc in the one vessel with the copper in the other by means of copper wire, as in Fig. 2.

We have now doubled our battery power, and so on, every cell we add and connect we increase the power.

So long as the cells are connected by the wires, the current generated will continue to flow, but if the wires be broken or disconnected the current at once ceases. The current is always supposed to flow from the zinc, through the liquid, to the copper, and thence by means of the connecting wires, or "circuit," as it is technically termed, back to the zinc. Thus in Fig. 1 it is shown by the arrow to be flowing from right to left, but by simply altering the connection of the wires it can be made to flow the reverse way. This flowing of the current is merely an arbitrary method of conceiving the action of the current, and though probably not theoretically correct, is practically the most useful method of describing the force generated by the battery. As it would, of course, be very inconvenient in practice to employ such cells as in Figs. 1 and 2, a more compact and convenient battery is used. It is a trough made of teak, divided into a number of partitions or cells, answering the purpose of the vessels employed in Figs. 1 and 2. These cells are again divided by partitions to keep the copper and zinc solutions separate. Fig. 3 shows the battery in question. It is called a 12-plate sulphate battery, there being sufficient cells to accommodate 12 pairs of plates. When the plates are laid in as shown, and the two sides, C, Z, brought into contact with the wire A, we have sufficient battery power to work an instrument within a short distance. Such a battery, if moderately though frequently used, will retain its power for a considerable time—ordinarily from six to eight

months. Excessive use causes, of course, a proportional consumption of sulphate of copper; on the other hand, if allowed to remain idle, the plates become covered with dirt or fur, and the action of the

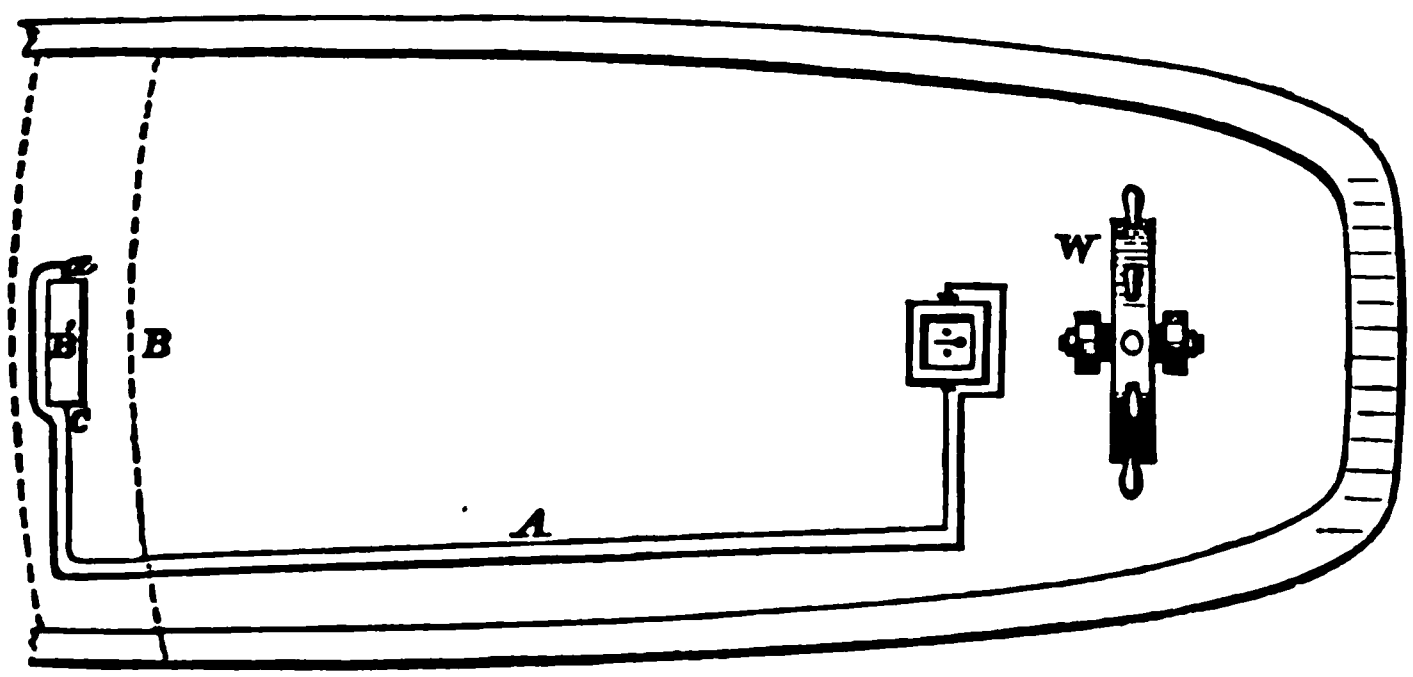
FIG. 3.



battery is destroyed, so that all that is required to maintain an efficient battery power is to see that the plates are cleaned from time to time, and that due supply of sulphate of copper be kept in the copper cells, and the connections perfect.

The battery being constructed, we will next consider the means employed to convey its influence to distant objects. A piece of wire (as shown in Figs. 1, 2, 3,) generally performs this office. The wire employed on board ship is copper covered with some insulating substance, such as india-rubber or gutta-percha. It is thus coated or insulated to prevent the different wires coming in contact with one another, or with the wet planks or water, as in either case the electricity would be dispersed. These wires convey the electric current as water-pipes convey water, or gas-pipes gas; so that if allowed to come into contact with water, or with one another, they would be as inefficient as leaky pipes, water being a non-electric or conducting substance, and allow all the current to escape. If we require to send an electric current from the bridge B to the wheel W (Fig. 4), we lay a wire (A) between these points, at B we join it to battery B at C. It

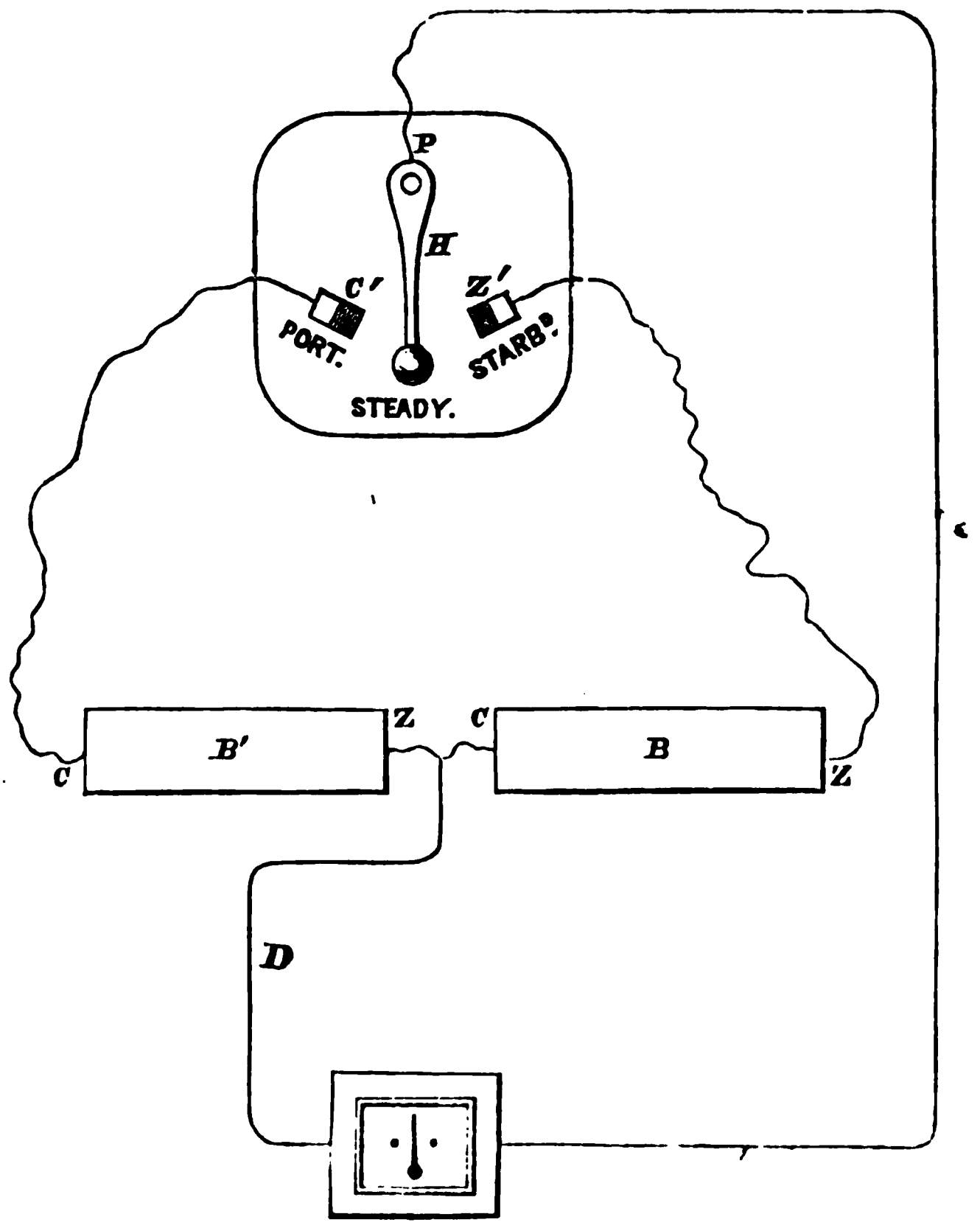
FIG. 4.



is, however, necessary to complete the circuit, that is to bring another wire from W to B at point Z. On land the earth is used to complete the circuit, but on board ship a return wire is necessary. Thus we have a continuous current flowing from B through the wire A to W, and if we inserted a sufficiently delicate instrument at W we should be enabled to read the signal transmitted from B. This current, and therefore the signal, is continuous as long as the wires are kept in connection with the battery, and is always the same if the current continues to flow in the same direction; but it can be interrupted if the wire be disconnected, or reversed if the connections of the wires be altered. To be constantly connecting and disconnecting by hand would be a tedious and unpleasant operation.

We have, therefore, an instrument called a key adapted to this purpose (Fig. 5). Let H be a metal handle (brass or copper) free to

Fig. 5.



work to the right or left (port or starboard) on a centre P, and so governed or regulated by springs or other means that it shall, unless designedly moved, be held as in the Fig. at steady.

From the Z of battery B join a wire to block Z′, and connect the other pole C of the battery to the return wire D. In the same manner connect the other poles of battery B′ to the block of the key C′, join the line wire A to the key handle H at P; the handle now communicates with the line A. In the case before us, then, we have, when the handle is at "port," the course of the current as follows: From battery B′ through its wire C to the contact point C′, upon which the handle is resting in full contact, thence into the handle and line wire, and so to the instrument I, and back by the return wire D to the other pole of the battery B. If we now bring the handle over to "starboard," we get an opposite current to that when the handle was at port, the battery B being connected up in the reverse manner to battery B′. The reversal of the current could easily be accomplished with the key with one battery only, but a second battery is adopted to simplify the construction and reduce the number of points of contact, which are always sources of mishap. It may be as well here to call attention to the necessity of keeping the points of contact Z′ and C′, as well as the points of contact in the handle, clean, otherwise the current will not pass. A piece of sand-paper will remove any dirt or crystals of salt that may clog them.

We now come to the instrument; the principal features of which are, viz., an indicator on the face of the instrument, moving in accordance with the index handle, H, on the fore bridge or station, and indicating port, starboard, or steady, as the operator desires. 2nd. A bell or gong sounded at either signal to port or starboard, thus calling attention doubly, by the deflection of the indicator and the sharp sound of the bell which is inside the instrument facing the wheel. The construction of the instrument is simple enough, it still, however, requires a little consideration of the power of electricity as regards magnetism, to understand it thoroughly.

The influence of a magnet on iron or steel, is too well-known to need comment, the action of the electro-magnet is not, however, so well-known. If we take a piece of soft iron, and wind round it a copper wire covered with silk, to prevent one lap of the wire coming in contact with the other, and then join the two ends of this wire, one to either pole of a battery, so that the electric current may pass through the wire, and so round the soft iron core; the core at once obtains magnetic powers, and becomes an electro-magnet; and if we bring it into proximity with a delicately hung magnet, it will attract or repel the magnet according to which current—positive or negative—is passing through the coil.

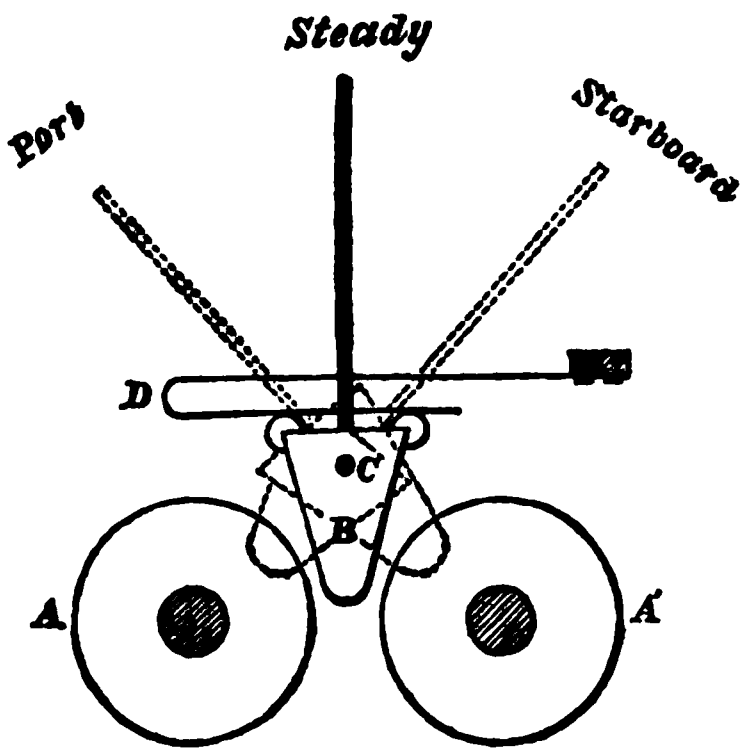
Fig. 6.

Thus, in Fig. 6, suppose A to be an electro-magnet, of which D

is the iron core, on sending a positive or copper current through it, we shall find that B will attract the north pole of a magnet, whilst C will repel it. On sending a negative or zinc current through it, the case will be reversed, C will attract the north pole of the magnet, and B repel it.

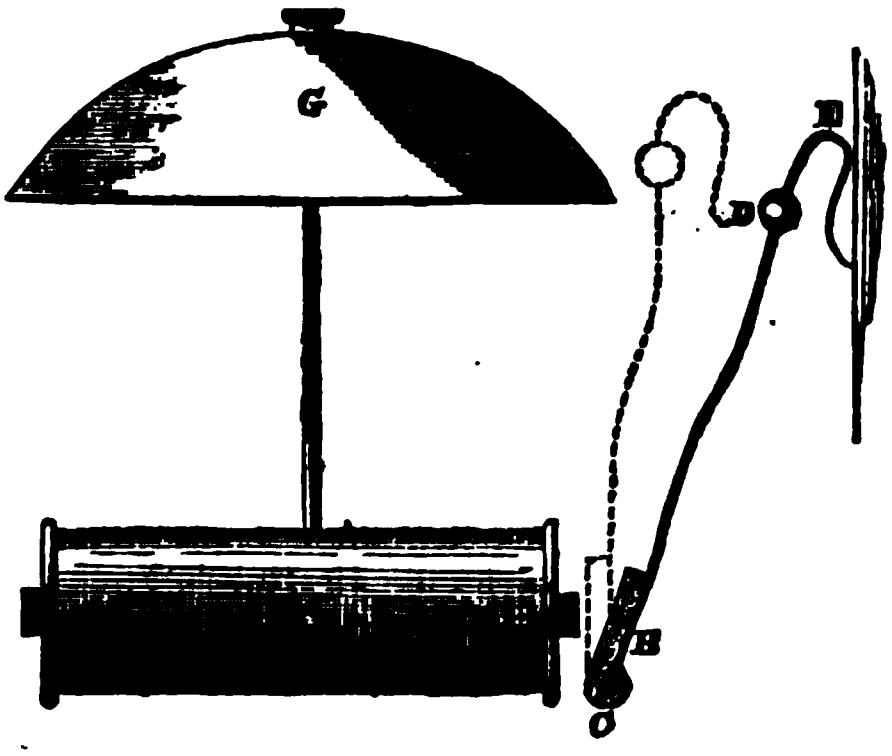
Let a pair of small coils, A A, be arranged as in Fig. 7, a magnet, B, working in a centre, C, between them, on passing a current through the coils, we shall find the magnet assume one of the dotted positions in the Figure, and if an opposite current be introduced, the reverse will be the case.

FIG. 7.



The movements of a needle or indicator attached to this magnet, will, of course, correspond to the movements of the magnet itself. It will be seen at once, that these two movements provide us with the signals, port and starboard. We have, however, a third signal, steady, to arrange; gravitation will help to give us this, but to insure a permanent signal, additional precautions have been taken. The magnet B has been provided with two small rollers, one at each of the upper corners, a small spring, D, presses against these rollers in such a manner as to retain the magnet, and consequently the indicator, in a perpendicular position when no electric current is passing through the coils. But the attraction of the electro-magnet is sufficient to overcome the pressure of the spring on the rollers, and deflect the needle. No sooner is the current withdrawn, than the spring causes the magnet to assume its vertical position. This spring is so arranged, that its readjustment is easy, should it ever get out of order. Thus we have the three signals, required, viz., port, starboard, steady, by means of which, in accordance with the following code, the officer in charge can order the helmsman to give any amount of helm, from "3 spokes" to "hard over." The movement of the key-handle not only causes the indicator to deflect, but also a bell to strike (Fig. 8) thus doubly calling attention; supposing this is the code adopted, one movement of the handle, which causes one deflection of the needle and one stroke of bell, means 3 spokes; two movements of handle, 6 spokes; three movements, 9 spokes, and so on. The handle moved rapidly several times, causes the needle to deflect, and the bell to keep ringing, and would show that the officer was in a hurry, and wanted the helm hard over short. We will now consider the action of the signal bell. This is effected by means of the same electro-magnet that is employed to deflect the indicator. A in Fig. 8, again, represents the electro-magnet; let B, the armature, be a

Fig. 8.



piece of soft iron working upon a centre, C, with a small rod and hammer D, fixed to it, and dependent upon its movement. E is a piece of wire passing through the head of the hammer to regulate the distance the armature is to be kept from the magnet; on a current passing through coil A, the armature will be at once attracted towards it with a quiet, sharp movement, and the hammer, D, if properly regulated, will strike the bell, G, and remain in that position as long as the current continues; on that ceasing, the hammer immediately falls back to its place of rest, until another current is sent. By this means, in conjunction with the indicator, we can order the helmsman to give any helm. For instance, if it be pre-arranged that each deflection is to mean three spokes, and twelve spokes, or a "turn of port-helm," is wanted, the officer in charge moves the handle four times to port, the indicator facing the helmsman deflects four times, the bell strikes four times, and the helmsman immediately gives a turn of port-helm.*

You will observe that the action shown in Fig. 8 is not the same as in Fig. 7; here (Fig. 8) the armature being merely a piece of soft iron, is attracted to the electro-magnet by every current passing through it, no matter whether positive or negative. In Fig. 7 the movement of the magnet is entirely dependent on the nature of the current employed, a positive current attracting it one way, and a negative another. The return signal by which the helmsman repeats the order received by him, to the officer in charge, is constructed precisely in the same manner as shown in Figs. 5 and 7.

It will be easily seen how the application of the same principle, can be applied to the conveyance of orders to any part of the ship. With a bell to call attention, and an indicator to point to the word of command, we have all that is necessary. The great object we have had in view in constructing this instrument, has been to make it as simple as possible; so that it can be easily comprehended, and in case of derangement, repaired by any ship's armourer.

The principles on which it is worked, and which I have detailed to you, are easily acquired, and the mechanical construction of the instrument is of the simplest nature. It may have appeared to those unacquainted with the science of electricity, that the minutiæ into

* As long as the key-handle rests at port the indicator points to port, and the helm will be kept to port.—A. H. G.

which I have entered are complicated and dry; but the principles enunciated are far more simple than those required to comprehend the compass, and *infinitely* simpler than the action of a steam-engine.

Electricity is but in its infancy. It is impossible to say to what purposes it may not be applied. When abroad it transmits our thoughts and wishes from distant lands to our dear old England. It guides and protects us in our rapid journeys along the iron highways. In Brussels, amongst other places on the continent subject to intense cold, whole streets of skeleton clocks may be seen keeping time by means of a guiding clock, through the agency of electricity. From the merchant's country house to his office, from the hall to the stable, from the dining-room to the kitchen, from the Admiralty to the Commander-in-chief of the Channel squadron, it alike attracts attention and conveys commands. It silvers our plate, and copies our engravings; it alleviates pain, and cures disease. Indeed, there are few purposes to which it is not applicable.

Its application to naval purposes is not its latest novelty, nor its least utility; and it is hoped that its adoption into Her Majesty's navy will lead to its ultimate introduction to navigation generally. I may here state, that we have our steering apparatus on board the following ships of the Royal Navy: Her Majesty's yacht "Victoria and Albert," the iron frigates "Resistance," "Hector," and "Prince Consort," the "Orlando," 50, and the "Orontes."

I and my partner, Mr. Preece, to whom I am indebted for electrical improvements in the apparatus, claim no merit for the invention itself. But we *do* claim priority in its practical introduction to naval purposes; and we take to ourselves the credit of having been the first to introduce to the Lords of the Admiralty the means of steering and working a ship by the electric telegraph.

The subjection to which science has reduced lightning, which is only electricity in a high state of tension, is a subject worthy of deep contemplation.

Imagine the look of amazement on the face of Old Benbow, Peter Parker, or other of the ancient mariners, if in the midst of a terrific storm of thunder and lightning, the wind howling, and rendering inaudible all words of command; imagine Benbow's face, if at the moment a consort's foremast had been struck by the electric fluid and shivered, some one had bawled into the old gentleman's ears through a speaking-trumpet, the future improvements of science. How Sir W. Snow Harris would insert a ribbon of copper down the masts and quietly lead this *dread* enemy into the sea, and there harmlessly disperse it. How, again, in future years science would hold prisoner this mortal terror, and make it work like any slave obedient to the motion of a finger. How, again, in a few more years, when England had spread her empire from sun to sun, *iron* ships three times the length, and six times the tonnage of the gallant old "Breda" that Benbow so nobly fought, would traverse the ocean without sails at the rate of 16 knots an hour. How, in the darkest night and in the fiercest gale, amidst all the confusion of a tremendous action, this imprisoned and fettered lightning would convey with its own immeasurable swiftness,

and the most perfect accuracy, orders from the captain to any part of the ship. What would have been the old sailor's astonishment? Fancy his look of mingled incredulity and wrath? And yet how calmly we look upon these improvements now, taking them as matters of course, and wondering why such things have not always been. In the next century, possibly, "our ancestors," as Paddy said, "will look back upon his posterity" in the same manner in which we look back upon the people of a past age. The wedge being introduced, and the ball of science set rolling, it will doubtless continue to roll, gathering daily every grain of science that the teeming brain of man conceives, and so keep on increasing in volume, and constructing of the diurnal atoms an offering to Him who endows us with reasoning power, until this world itself shall cease to roll its daily course. I have said before that all classes of society on shore *have* their electric telegraphs, and I therefore submit to *this Institution* that it is very hard that sailors should *not* have theirs; and I would also move that this Institution do consider the necessity of applying electricity to certain nautical purposes, believing that should we fit the apparati, sparks will not fly from the wires and set fire to the loose powder about the decks, as some officials to whom the subject was explained have feared, though we can, if we like, by frictional electricity discharge a ship's broadside as one gun.

FLEXIBLE COFFER-DAMS FOR CLEANING AND REPAIRING SHIPS AFLOAT.

By Captain H. F. M'Killop, R.N.

The very limited dock accommodation available for our large ships, either at home or abroad, has now become a serious consideration, both to the Government and mercantile naval authorities. The almost universal use of iron for ship-building, is only checked by the frequent necessity now existing for docking iron ships, to remove the incrustations, weed, &c., which so rapidly form on their bottoms; not large ships only feel this want of dock accommodation, "for in many parts of the world where our ships of war are frequently stationed for three or four years, and to which numbers of our merchant ships are constantly trading," no docks or other convenience for cleansing, painting, or repairing the bottoms of our ships, exist *at all*. Heaving down the long flat-floored ships of the present day would be a long and dangerous process, and in the case of a steamer almost impossible without removing her machinery. The helmet and diving dress, although most useful for examining the bottoms of ships afloat, and even for effecting trifling repairs, does not at all meet the necessity. Coffer-dams have for many years been used for these purposes, but hitherto they have invariably been constructed of rigid material made

expressly, and after the accident had happened, *to fit any one particular part* of the hull, where repair was needed. This was the case with the "Great Eastern," after her accident off New York.

The great expense and delay necessary to fit such coffer-dams renders their use of rare occurrence, and I have only alluded to them, as the machine to which I wish to call your attention bears an affinity to them; but instead of being constructed of rigid material to fit one particular section of the ship, it is made of a flexible material, and capable of being applied to any part of the ship for which it may be made. I claim for this machine the advantage of being inexpensive and portable; when rolled up, not occupying more space than a rain awning or a topsail; the circular backed ladder which goes down inside the coffer-dam, takes to pieces and stows away in a case "*not so large* as a *midshipman's chest.*" The air pump (where one is needed) is quite a small affair. I say where one is needed, because all ships having Gossege's or Hearl's pumps, such as are used in Her Majesty's service, need not have the air pump, as those pumps answer the purpose of inflating the cylinders or tubes by simply taking off the suction and drying the pump well out before using it. My triangular coffer-dam is simply a modification of the other, made to be used at the bow and stern, supported in one case by the bowsprit, and in the other by a spar placed there for the purpose. These machines, although not so portable as the *jacket*, are very important, inasmuch as they enable you to examine and repair your stem and stern post, or in screw steamers with non-lifting screws to do the same to them. As to the question of light to enable the men to see under the bottom, simply a globe-lamp or police light lowered down inside the ladder, answers all purposes, and is only required under the floor.

I now come to the cleaning process without using a coffer-dam; for iron ships up to the present time this has been a great necessity, for although numerous inventions have been announced (my own amongst others) *no one* has yet succeeded in producing a *composition*, the use of which would enable an iron ship to be kept three years on a station where she could not be docked; in fact it is very rare to find an iron ship kept perfectly clean even for a year.

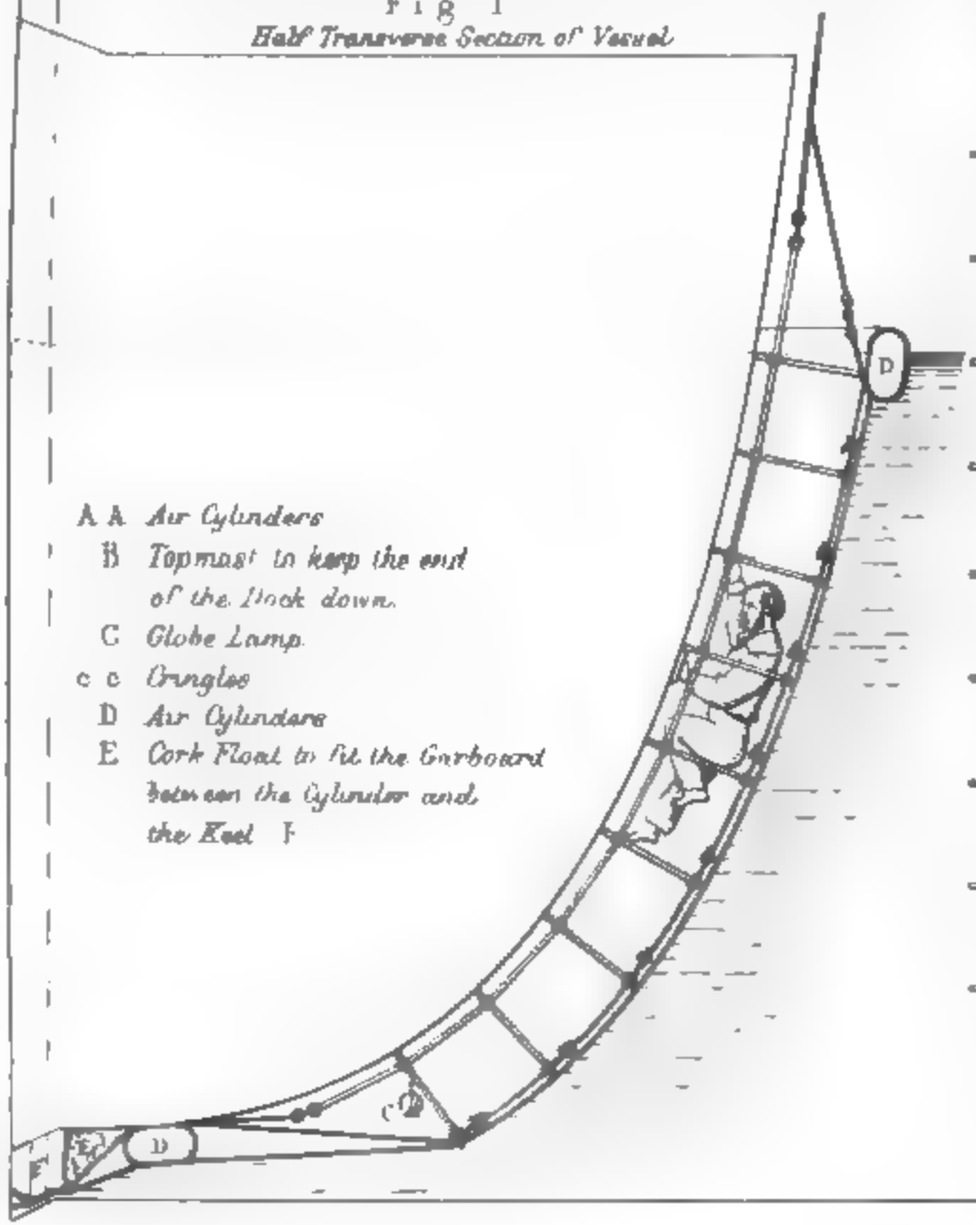
Failing the means of *keeping* ships clean, it becomes necessary to have the means of cleaning them when they become foul. One side of the flexible machine I propose to use, as I have already done, for the purpose of quickly and thoroughly cleaning the bottom of a ship, not by the process of scrubbing or scraping, but by the use of unslaked lime introduced between the ship and the canvas lining, which lime being slightly wetted, soon in the process of slaking, destroys all animal and vegetable life, which may then be readily and thoroughly removed, by the machine being drawn along the bottom, some of the air having previously been allowed to escape from the cylinder, in order to ease the pressure of the machine from the ship's bottom.

In the machine made for the "Recruit" I have brushes introduced near to the cylinders on the off side, simply to remove the lime and any foul matter on which it has already acted. I do not believe in scrubbing iron ships. I have been told by many who have scrubbed their ships,

MACKILLOP'S SYSTEM OF CLEANING SHIPS BOTTOMS

Fig 1

Half Transverse Section of Vessel



A A *Air Cylinders*
B *Topmast to keep the end of the Dock down.*
C *Globe Lamp.*
c c *Gringles*
D *Air Cylinders*
E *Cork Float to fit the Gurboard between the Cylinder and the Keel* F

Fig 2

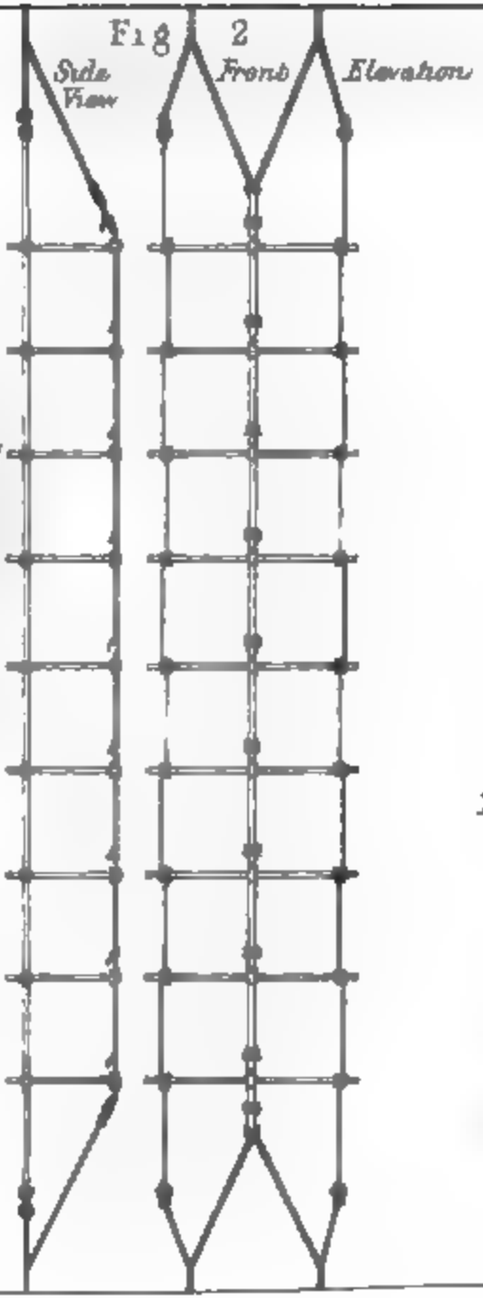


Fig 3

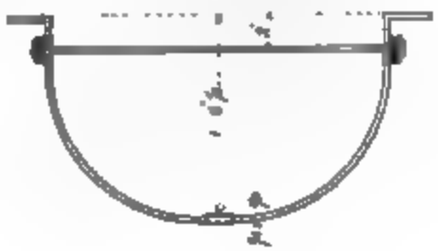
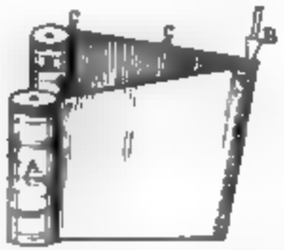
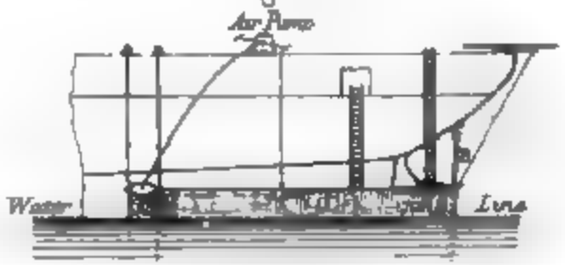


Fig 4



Triangular Dock or Coffer dam for Bow or Stern

Fig 5



H B M M°K.

particularly in tropical climates, that after one scrubbing, the growth is three times as quick and is much thicker than it was before. Indeed, I believe that the hogging process at sea only tends to irritate the grass, much as our brushing and sweeping our lawns on shore tends to stimulate the growth of the grass. Whether it is the same with the fish I do not know. The foul matter removed from the "Recruit" in my first attempt at acting upon it by lime, clearly proved that both animal and vegetable life were thoroughly destroyed by the action of the lime, and that life had to be renewed by a new formation. I do not say that in a short time a new formation would not exist, but by destroying it with lime you have this advantage over scrubbing, that you destroy the germ of the animalcule and the seed of the grass.

The evident utility of this machine for stopping a leak needs no comment, the simplicity of its application and the closeness of its fit to the hull, are easily seen. Another purpose for which it may be used is for a *float* or pontoon; by doubling the machine and lacing the parts together, a sort of boat is formed, so buoyant that for landing on a lee-shore through a surf, few boats, built expressly for the purpose, would answer better. In conclusion, I beg to point out, that I do not confine myself to one or two materials for the construction of the air tubes or lining of these machines—in some cases I would use india-rubber, or rather canvas prepared with india-rubber; and in other cases leather riveted as in our hoses; and I propose to try vulcanized rubber, with canvas coverings faced with fearnaught, and luted with beeswax and tallow, on the part of the cylinder which comes in contact with the ship's side and bottom.

In the meantime I have confined myself to leather and india-rubber, and have succeeded, as far as the principle is concerned. The thing is still in its infancy; I trust it may be further developed as a useful means of getting under water to examine ships without the use of diving dresses, and without the great expense of sending ships home from foreign stations to be docked.

I must apologise for the roughness of my models, but the half-pay of a sailor who has to develope the merits of an invention admits of no extravagance in that direction.

The flexible-jointed ladder shown in Figs 2 and 3, is used as a means of going down the ship's side, inside the canvas machine. Fig. 3 shows the arched back piece which prevents the man from being jammed up against the ship's side by the pressure of the water outside, and also gives him room to use a scraper, brush, or other tool, after the water has been pumped out of the coffer-dam thus formed.

Fig. 4 shows triangular dock or coffer-dam for bow or stern. Fig. 5 the same applied to the stern. This figure shows the stern higher out of the water than would be the case under ordinary circumstances.

LECTURE.

Friday, March 18th, 1864.

LIEUTENANT-COLONEL T. ST. LEGER ALCOCK, Vice-Chairman of Council, in the Chair.

THE ART OF COMMAND CONSIDERED WITH REFERENCE TO THE DUTIES OF REGIMENTAL OFFICERS.*

By Lieutenant-Colonel A. CUNNINGHAM ROBERTSON, 8th, The King's Regiment.

COMMAND is the peculiar and characteristic function of every individual holding military rank above that of a private soldier. The greater or less capacity for the exercise of this function measures the fitness of the non-commissioned as well as of the commissioned officer for the rank he actually occupies. It determines the expediency of promoting him to a higher rank.

The authority of the corporal is derived from the same source as that of the colonel. It invests both with the same right to exact absolute obedience; it imposes on both the same obligation to use the power confided to them conscientiously, discreetly, and with a sympathetic consideration for the feelings of those placed under them; it is given to both as a trust to be exercised for promoting the same ends, viz., the good of the service, the maintenance of discipline, the

* In preparing this lecture I have borrowed several illustrations from Colonel Rolt's work on Moral Command, the only book in the English language with which I am acquainted which treats of the subject of the lecture. This work is rather desultory and unsatisfactory in its arrangement, but it contains very interesting statements of the results obtained by the writer by carrying out, when in command of a regiment, the system he recommends.

I have also embodied in my lecture certain views regarding the mode in which authority should be exercised, derived from writers on the government of schools and families, to whose works reference will be made at those parts of the lecture which are borrowed from them.

The idea of this lecture was first suggested to me by hearing an admirable discourse on obedience, delivered by one of these writers, the Rev. Dr. Robert Lee, Professor of Biblical Criticism in the University of Edinburgh.—A. C. R.

preservation of good order, and the exact performance of the appointed duties of their respective offices. Moreover, if any one invested with military authority exercises that authority oppressively, vexatiously, indiscreetly, or unkindly; if a command be given which is harsh, selfish, or unjust; which is useless, or frivolous, or contrary to custom; which is impracticable, inconsistent with other orders, or ill suited to the circumstances of the case; or which, though legitimate and proper, is enforced in an impatient, ill-tempered, or violent way, without sympathy or consideration for the feelings, the weaknesses, and the prejudices, of those who have to obey it, he who gives such a command, whatever may be his grade, whether he be a colonel or a corporal, abuses the authority with which he is invested, and fails in the performance of that function which is the essential characteristic of his rank.

Since, then, the authority of officers and non-commissioned officers of every grade is the same in kind, since it is derived from the same source, has the same claim to obedience, imposes the same duties, is given for the same ends, and is liable to the same abuses, is it not the bounden duty, not only of every officer, but of every non-commisioned officer, anxiously to consider what are the exact limits of his authority? What are the qualifications required for its efficient exercise? What are the general principles, and what the specific rules by which he must endeavour to regulate his conduct in dealing with those under his command?

Obedience is the co-relative term of command. It is the result which he who gives the command desires to obtain. Now, whether a command be obeyed or disobeyed, depends on the respect which is left for the authority of him who issues the order. The art of command may therefore be defined to be "*the art of using those means which are most suitable for ensuring respect being paid to authority.*"

He who exercises authority may rely on three different classes of motives. He may rely on motives which appeal to the hopes and fears, or on those which appeal to the reason and conscience, or on those which appeal to the affections of those under his command. Of these three classes of motives, those which appeal to the hopes and fears are doubtless the most energetic in their action, and the most easily applied. In time of peace, when soldiers are confined within the four walls of a barrack-square, it is, no doubt, possible for an officer, who possesses neither the confidence nor the love of the soldiers under his command, to maintain discipline merely by the use of those powers which the law places at his disposal for compelling obedience, and for punishing those who attempt to resist his authority, or who neglect to obey his commands. But in the field, where the opportunities and temptations to transgress rules are multiplied, where the means of restraint are diminished, and where the service required from the soldier is not merely the exact performance of certain prescribed exercises, but the exertion of every power he possesses—nay, even the devotion of his life at the command of his officer—it is obvious that a system of terror must utterly break down, and that no officer will prove an efficient commander who does not possess the qualities which attract

love and inspire confidence; who is not skilful in the use of those means which enable an officer to exercise a powerful personal influence over the opinions and affections of soldiers.

If, therefore, an officer desire to exercise the authority committed to him in the only way calculated to secure the ends for which that authority is given, he must fix his attention, not on the conditions under which authority is exercised in the barrack-square, but on the conditions under which it is exercised in the field. If he does this he can scarcely fail to see that obedience (however exact and perfectly rendered), if it be merely the result of the vigorous use of severe compulsory means, originates in an inadequate and defective motive. He can scarcely fail to see that the obedience of soldiers to be of real military value, must be not only exact and absolute, but that it must also be willingly and cheerfully rendered. That the spring from which it derives its origin and persistent force must not be the slavish feeling of fear, but the noble feeling of implicit confidence and of sincere personal attachment. He can scarcely fail to see that in order to exercise his authority effectively, he must not trust solely or even principally to the use of force, but must chiefly rely on that moral influence which can only be acquired by the exercise of firmness, the manifestation of wisdom, and by the practice of kindness.

The general principle from which all rules for the successful exercise of the art of command are derived, may be stated in a single sentence:—*Make obedience as easy and as agreeable, disobedience as difficult and as disagreeable as possible.*

The application of this principle is quite independent of the organization of the body to be governed, or of the particular objects or purposes for which the authority of the governing power is exercised. The same mode of exercising authority which is suitable for the command of a regiment, is suitable for the government of a family, of a school, of a ship, of a fleet, of an army, of any organized body, which is required to obey the orders, and to act under the directions of a single chief.

The rules which must be observed, and the conditions which must be fulfilled by the commanding officer of a regiment, are precisely the same as those which must be observed and fulfilled by his subordinate officers and non-commissioned officers, by the captain in the management of his company, by the sergeant or corporal in maintaining order in his room. The corporal is under precisely the same obligations as the colonel, so to exercise his authority as to secure the willing and cheerful obedience of those under his command. The obligation of both is the same, the result aimed at is the same, and that result can only be obtained by the one, through the use of the same means as must be employed by the other. Whatever be the amount of authority entrusted to him who commands, and whatever be the nature of the service he is appointed to exact—that obedience which originates in feelings of respect, confidence, and love, will only be yielded to him whose authority is exercised with firmness, with discretion, and with kindness. He, therefore, who desires so to exercise

his authority as to make obedience easy, and to inspire those under him with feelings of respect, confidence, and love, must take care that his commands are as few as possible; that they are reasonable, just, and necessary; that they are uniform and consistent; that they are proportioned to the strength of those who have to obey them, and that they are strictly enforced. Regulations or orders which want any of these attributes, must, to the same extent, fail to secure the willing and cheerful obedience of its soldiers. On the other hand, by indulging in the caprices of a selfish or arbitrary disposition, by inconsistency in his orders and requirements, by demanding in the heat of temper what is felt by himself in cooler moments to be harsh, impracticable, useless, or unreasonable, and what therefore cannot be strictly enforced—by these and such like faults an officer will excite feelings of hatred and contempt, which even if they do not break forth in open acts of insubordination and defiance, are nevertheless quite incompatible with the efficient and salutary exercise of military authority.*

The following rules exhibit a statement in detail of the principal considerations which an officer ought to keep continually in view in the exercise of his authority, and by reference to which he ought to accustom himself to test the propriety and expediency of every order he issues. These rules are:—

I.—Take care that compliance with orders shall always be attended with advantage, and that disobedience and neglect shall be invariably punished.

II.—Before issuing an order, consider well what means are available for ascertaining that it is strictly complied with, and make careful arrangements for the supervision of its execution.

III.—Issue as few orders and impose as few restraints as possible.

IV.—Take care that every order issued is legal, just, and useful.

V.—Take pains to render the reasonableness and utility of every order that is issued, manifest to those who have to obey it.

VI.—Take care that every order is expressed in concise, simple language, free from ambiguity, and so framed as to be distinct, and easily understood. When an order is given verbally, the tone of the voice should be decided and free from hesitation.

VII.—In giving directions concerning the method of carrying out an order, take care not to impose any unnecessary labour.

VIII.—Before issuing an order, take care that all necessary arrangements are made for facilitating its execution.

IX.—In issuing a new order, take care that it does not contradict or in any way impede the execution of any former uncancelled order.

X.—When, by a change of circumstances, an order becomes superfluous or mischievous, do not permit it gradually to fall into disuse, but let it be explicitly cancelled. The same rule applies when a mistake has been made, and an order issued, which is found to be improper or inexpedient.

XI.—So manage as never to have the laugh against you.

* Vide "The Family and its Duties," by the Rev. Dr. R. Lee, p. 82.

XII.—In framing regulations and orders, endeavour to adapt them to the convenience of those by whom they are to be obeyed.

I shall now endeavour briefly to illustrate the bearing of these rules on the details of regimental management.

Rule I.

Take care that compliance with orders shall always be attended with advantage, and that disobedience and neglect shall be invariably punished.

Although the power of conferring rewards and of inflicting punishments must always be the foundation on which authority rests, yet the chief aim of every one invested with authority should be, to secure obedience without exercising this power. An officer should accustom himself to consider the necessity of ordering punishment, as a proof of failure, he should regard the amount of success that attends his efforts to maintain discipline, without the infliction of penalties, as the measure of the degree of skill he has attained in the art of command.

The most effectual means of diminishing the frequency of punishment, is to make its infliction certain. A very slight penalty (provided there be no chance whatever of escaping its infliction) will operate more effectually in deterring soldiers from the commission of crime, than the liability to a penalty of the most extreme severity, but the infliction of which is rendered uncertain, either by facilities for concealing guilt, or by the too frequent or the capricious exercise of the power of remission.

The efficacy of punishment is therefore not in proportion to its severity, but in proportion to the certainty of its infliction. Indeed, great severity is not only unnecessary, it is positively injurious. It has a tendency to tempt non-commissioned officers and witnesses to screen offenders, and to conceal crime.

If it happens that the officer who has to administer a rigorous system, thinks it too severe, he is apt to construe facts and evidence, with an undue bias, in favour of the prisoner, and also to make arbitrary exceptions and remissions, the effect of which is, to diminish the certainty of crime meeting a fitting retribution, and therefore to increase the temptation to commit offences.

That system of punishment is most likely to be efficacious, which imposes penalties of moderate severity, so graduated as to discriminate between men who seldom commit offences, and whose general character is good, and men of bad character, who are habitual offenders; which defines with precision the cases in which these penalties will be inflicted, and which is so efficiently, impartially, and consistently administered, that few offences are committed which are not detected, and that no offence is detected which is not visited by the prescribed penalty.

The effect of previous good conduct in averting or diminishing punishment, should be regulated by general rules; all cases which are similar in their character should be punished by the same penalties. I select three cases of the offences most frequently committed by soldiers, to illustrate the manner in which rules may be framed for

awarding punishment in a systematic way, according to a graduated scale.

Ist Crime.—Late turning out for parade or roll-call.

Punishments.—If 6 months clear on the defaulters' book, reprimand by the captain.

2nd offence within 6 months, 3 days confined to barracks (to be awarded by captain without confining soldiers).

3rd offence within 6 months, 7 days confined to barracks.

4th offence within 6 months, 10 days confined to barracks,

IInd Crime.—Absence from tattoo, not exceeding 24 hours.

Punishment.—If 12 months clear of defaulters' book, reprimand.

If 6 months clear on defaulters' book, 7 days' confinement to barracks.

2nd offence within 6 months, 10 days' confinement to barracks.

3rd offence within 6 months, stoppage of pay, and 14 days' confinement to barracks.

4th offence within 6 months, stoppage of pay, and 21 days' confinement to barracks.

5th offence within 6 months, stoppage of pay, and 28 days' confinement to barracks.

6th offence, stoppage of pay, 168 hours' imprisonment, 14 days' confinement to barracks.

7th offence, regimental court-martial.

IIIrd Crime. Drunkenness.—If 12 months clear of defaulters' book, reprimand.

2nd offence within 12 months, 7 days' confinement to barracks.

3rd offence within 12 months, 14 days' confinement to barracks.

4th offence within 12 months, 28 days' confinement to barracks; or if within 3 months of previous instance, 168 hours' imprisonment, and 14 days' confinement to barracks.

5th offence within 12 months, regimental court-martial for habitual drunkenness.

The establishment of a graduated scale of punishments for minor offences is most useful in preventing officers in command of detachments from dealing with defaulters more or less leniently than they are dealt with at head-quarters; but its principal utility consists in keeping the manner of dealing with crime at head-quarters uniform; and preventing any inconsistency between punishments awarded by the Lieutenant-Colonel and those awarded by officers in temporary command. Indeed, unless some scheme of awarding punishment be deliberately formed and adhered to, it will be found even when no change occurs in the commanding officer, that the manner of dealing with offences will not be uniform, and that a commanding officer is very liable to incur the imputation of partiality by awarding to precisely similar offences, committed at different times, very dissimilar penalties.

It is much more difficult to deal with the offences of non-commissioned officers, according to a uniform scale, than with those of privates.

There are many irregularities and neglects for which reduction

appears too severe a punishment, and yet which either in their own nature, or on account of having been more than once repeated, are too serious to be adequately dealt with by a mere reprimand. In cases of this kind, a commanding officer frequently feels it very difficult to decide how to act, and is apt occasionally to come to opposite conclusions regarding offences precisely similar in their character.

To enable a commanding officer to deal satisfactorily and consistently with the offences of non-commissioned officers, I think power should be given to him to impose fines, and award stoppage of part of their pay for a limited period. I think also, that in dealing with sergeants convicted of such offences as neglect of duty, or of conniving at, or failing to report irregularities, a discretion should be allowed to courts-martial of reducing them to the rank of corporal instead of to the rank of private.

The chief power of reward vested in a commanding officer is that of selecting men for promotion, but by making the granting of passes, furloughs, and other indulgences, dependent on good conduct, and by exempting well-conducted men from some of the ordinary parades and roll-calls, the efficacy of this means of government may be very considerably increased.

The attainment of certain desirable objects, such as attendance at school, which it may not be expedient to enjoin imperatively, or to enforce by the infliction of penalties, may also be effected by the judicious employment of suitable inducements, such as exemption from some parades and from all fatigues.

Rule II.

Before issuing an order, consider well what means are available for ascertaining that it is strictly complied with, and make careful arrangements for the supervision of its execution.

The practical difficulty in the art of command, does not consist so much in determining what orders are proper to be issued, as in keeping up a system of efficient superintendence, and in the energetic exercise of personal vigilance, so as to make sure that whatever order is given, shall be strictly complied with.

To organize such a sytem of superintendence as shall ensure exact compliance with whatever orders may be issued, is of more importance than to determine in each particular case what orders are most expedient and most fitted to attain the end in view. Whether a particular order be useful or superfluous, judicious or injudicious, expedient or inexpedient, may sometimes be a matter of very small importance—almost of indifference. The mischief done by an improper order, depends on the greater or less importance of the matter to which the order relates. If the matter be trifling, the mischief done by the improper order will also be trifling. But the mischief done by permitting an order to be neglected or disobeyed, in no degree depends on the subject to which the order relates, in any quality of the order itself. Whether an order be right or wrong, expedient or inex-

pedient, important or trifling, the injury done to discipline by neglecting to enforce exact compliance with what is prescribed, is the same. Whether, for instance, soldiers sit down to dinner with their jackets buttoned or unbuttoned, is a matter of no great importance, and, therefore, it cannot matter much what order a commanding officer thinks proper to give about the dinner dress. But if he decide that the jackets shall be buttoned, and gives an order to that effect, then it becomes a very important matter that the rule laid down should be strictly adhered to, and if he suffer the order he has given respecting this trifling matter to be neglected, he suffers a very serious injury to be done to the discipline of his regiment.

The difference between a regiment which is well commanded, and one which is ill commanded, will be generally found to consist less in the nature of the orders issued, than in the manner in which they are enforced. No orders, however excellent, will produce satisfactory results, unless enforced by a good system of supervision, but no system of supervision, however skilfully framed and perfect in theory, will work well unless directed and controlled by a vigilant and energetic chief.

In the command of a regiment, the same rule holds good as in the general conduct of human affairs—men come first, measures afterwards. An energetic commanding officer working with a bad system, is to be preferred to a good system carried on by a feeble, irresolute chief.

The practicability of enforcing obedience, is then a matter which must be always carefully considered before issuing an order. If in any particular case it be foreseen that this essential condition cannot be secured, an officer, instead of attempting to obtain the desired result by means of a direct order, should rather endeavour to accomplish what is wished to be done, in some other way.

Rule III.

Issue as few orders, and impose as few restraints as possible.

The problem to be resolved in the government of soldiers is the same which presents itself in all possible governments. "The "thing to be done is always the same: to reconcile the greatest "possible amount of individual liberty, with the most perfect submission "to law."* Zealous and energetic commanding officers sometimes act as if this statement of the conditions of the problem were erroneous, as if the true object to be aimed at were, not to increase the amount of liberty allowed to the soldier, but to restrict it within the narrowest possible limits. As if the amount of liberty he actually possesses were a proof of failure, a thing to be regretted, an imperfection to be remedied.

Numerous minute regulations harass and irritate the soldier. He is also harassed, if the work of instruction, or the work of superintendence, or both, be overdone by parades of unnecessary length, or by inspections of unnecessary frequency.

* L'Education Progressive, par Madame Necker de Saussure.—Liv. 1, chap. v.

If the constant meddling of a commanding officer with matters where his interference is not required, be harassing to the soldier, still more mischievous and intolerable is the meddling of an over zealous non-commissioned officer. Although prevention is better than cure, yet it is certainly better for a non-commissioned officer to permit men to run the risk of being occasionally punished for neglect, than to be continually reiterating orders and tormenting men by directions and inquiries concerning their execution. Admonitions and exhortations, to be effective, must be seldom employed: nothing is more irritating, and more certain to create feelings of dislike and contempt, than habits of constant interference and fault-finding.

That system of management which, with the view of diminishing temptation to crime, is opposed to granting passes and indulgences, appears to me contrary to the principle of this rule. Let all possible means be taken to induce men to avoid and to resist temptations. Endeavour to foster tastes for innocent recreations; and to create facilities for the indulgence of such tastes; punish every instance of depravity or vicious indulgence, but do not treat soldiers like children or convicts. Do not attempt to render crimes impossible by the extinction of liberty.

The standing orders of a regiment should be few in number, they should be perfectly clear and concise, not liable to frequent exceptions, nor limited in their application to particular times and circumstances. The principal matters which ought to be defined in the standing orders are—

1st. The routine of daily and weekly duties, specifying the respective duties of the captain and subaltern of the day.

2nd. The daily and annual routine of parades and exercises.

3rd. The manner and periodical times of auditing the company, mess, band, and quartermaster's accounts.

4th. The inspection of necessaries, arms, and accoutrements.

5th. The conditions of granting passes, furloughs, and indulgences.

6th. The rules to be observed in inflicting minor punishments, including the definition of the classes of offences to be dealt with by captains of companies.

8th. Regulations for the selecting and promoting non-commissioned officers, specifying the conditions of conduct and service, and educational qualifications required for each rank.

In determining the number and duration of parades, the number of passes to be granted to each company, and generally in deciding upon any matter which either affects the amount of work to be exacted from soldiers, or the degree of restraint to be imposed upon them, a commanding officer ought not to be guided merely by his own notions of what is reasonable and proper. He ought neither to exact more work, nor to impose more severe restraints than is sanctioned by the general practice of the service.

A commanding officer is under no obligation, nay, he is invested with no authority to enforce conformity to the rules of morality further than is required for the maintenance of military discipline. I remember hearing of a non-commissioned officer being placed under arrest

for having been seen talking with a prostitute in the bazaar of an Indian cantonment. It appears to me that in this case the exercise of the power of arrest, if not absolutely illegal, was undoubtedly very injudicious. If the right, or at all events the expediency of using military authority to enforce the observance of moral rules be limited to cases in which their violation is clearly prejudicial to discipline, we see a reason why certain irregularities may be tolerated in the quarters of an officer, which it would be necessary to punish most severely if committed in a soldier's barrack-room.

The obligation to abstain from using military authority to promote any other ends, however excellent, than those specific ends for which it is given, is perfectly consistent with the still higher obligation imposed upon officers as upon all other men, both by their example, and by exerting their personal influence upon those with whom they are connected, to do all in their power to promote virtue, and to discourage every species of immorality. A commanding officer is bound so to speak and act that his toleration of certain infringements of morality shall not be construed to signify sanction and approval.

Rule IV.

Take care that every order that is given is legal, just, and useful.

The motives which tempt officers to issue orders of questionable legality are frequently laudable. One of these motives, viz., zeal for the interests of morality, has just been discussed. Another somewhat analogous motive is a desire to excel, the ambition to command soldiers distinguished by the smartness of their appearance. Orders to soldiers to provide themselves with any article not required by regulation, or with necessaries of superior quality, such as smart forage caps or padded jackets, are instances of the violation of the rule proceeding from this motive. So also are the inconsiderate and very oppressive orders sometimes given by captains, that new articles of clothing shall be provided before the old ones are worn out.

If soldiers are attached to their officers and animated by a strong *esprit de corps*, they may be easily induced to acquiesce in any moderate extra charge thought necessary to keep up the credit of the corps, and to increase its reputation for smartness of appearance. But however strong the general feeling may be in favour of submitting to the charge required by the commanding officer, there will always be a certain number of individual grumblers, anxious to evade the change and dispute the order. To avoid even the slightest risk of compromising his authority, a commanding officer should never on any consideration issue an order, the legality of which is liable to be questioned and disputed even by a single soldier.

Unjust, as distinguished from illegal orders, generally arise from faults of temper; sometimes, but much more rarely, from errors of judgment. It is only in rare and exceptional cases that an officer is misled by misrepresentations, or that he forms an erroneous estimate of evidence, but there are many officers who are habitually

influenced by feelings of favouritism or of aversion; and there are very few who in dealing with individuals are not occasionally biassed by personal likings and dislikings. Even in issuing orders of general application, an officer of an irritable temper may be provoked to order a whole company to attend extra drill on account of the mistakes of the officer who commands it; or, still worse, he may order extra drill on account of mistakes occasioned by the indistinctness of his own word of command. When any penalties or restrictions are imposed upon a whole body of men, such as a company or a regiment, on account of the misconduct of a limited number of individuals, it is essential that the expediency and utility of the order should be clearly manifest, and that not the smallest appearance of passion or want of consideration should be exhibited in the issue of the order. A good means to prevent dissatisfaction with orders of this kind is, whenever practicable, to define before hand the cases in which they will be issued, *e.g.*, to give notice that whenever a man is absent from tattoo, a certain number of files of the company he belongs to shall be sent out to look for him; or that when the number of defaulters in a company exceeds a certain number, the passes of that company shall be stopped.

Useless orders are of two kinds, those which prescribe unsuitable means for the accomplishment of a useful end, and those in which, though the means prescribed are well adapted to accomplish what is required to be done, the object sought to be accomplished is itself useless or improper.

No officer ever issues an order which he himself perceives at the time is not suitable to the circumstances of the case, but when an order has been once issued, it is frequently obstinately enforced, although experience has proved, and he who gave the order very well sees, that it is useless or injurious. There can be no doubt that the admission of failure implied by cancelling an abortive order has a tendency to diminish the confidence felt in the judgment of a commanding officer, and to weaken the respect felt for his authority; but to persist in an error does not conceal it, and to enforce the doing of that which is manifestly useless or mischievous, creates feelings of irritation and dissatisfaction far more prejudicial to the authority of a commanding officer than the mere diminution of confidence produced by the perception of error or failure.

Before issuing an order an officer should consider well how it will work. He should consult those best qualified to give him reliable information or sound advice. He should seek to ascertain whether what he considers advisable is considered advisable by others also, who look at what he proposes from a different point of view. In special cases this precaution is seldom neglected. Few officers would think of issuing sanitary regulations without consulting the doctor. It seems to me that it would be wise, even in the most ordinary cases, and as a general rule, to issue no order whatever without consulting those by whom it is to be obeyed. Officers should, I think, be consulted about mess regulations; captains of companies about transfers, promotions, punishments, and indulgencies; pay-ser-

geants about matters of account; the adjutant and drill instructors about parades and exercises; and private soldiers about the fitting of their accoutrements, the packing of their knapsacks, the material and fashion of their clothing, and the arrangement of their barrack-rooms.

Officers of an arbitrary disposition are apt to feel irritated and impatient when any difficulties or obstacles are stated, which it is foreseen will impede the execution of the orders which they propose to issue. Such officers seem to imagine that to listen to objections implies weakness and want of confidence in their own judgment. The reverse of this is true; generally speaking those officers who are most willing to listen to the opinions of others, and most disposed to seek for advice and information, are those who are most conscious of possessing the power of dealing with difficult questions, of estimating the worth of conflicting opinions, of answering objections, and of discovering expedients to remove obstacles and to overcome difficulties. Those officers, on the contrary, who make a mystery about everything, who carefully conceal their intentions, who avoid discussions, and who resent the statement of difficulties, though they may be energetic and possessed of a strong will, are, generally speaking, men of inferior intellect, men who are only able to look at a subject from a single point of view, who are perplexed, not enlightened, by the statement of conflicting opinions, who, because they possess few resources for obviating difficulties, are puzzled and provoked when difficulties are brought to their notice.

When any doubt exists as to the manner in which an order will work, it should be first issued as a tentative measure for a limited period, at the end of which reports should be called for.

As an instance of the use of unsuitable means to promote a necessary end, may be mentioned the practice, lately prohibited, of frequently washing floors and passages as a means of keeping them clean.

The other class of useless orders are those in which the means prescribed are appropriate, but the end proposed is useless, that is, does not conduce to any necessary military object. An exaggerated love of method and uniformity is perhaps the most prolific source of superfluous and mistaken orders. How many vexatious, utterly useless regulations have originated in perverted notions regarding what is necessary to give a soldier a smart military air. Without adverting to the powder and pigtails of the days of our grandfathers, when it is said that in order to pass muster at a full-dress morning parade it was necessary for a soldier to begin dressing the night before, we know that, only the other day, the Commander-in-Chief found it necessary to caution officers against insisting on great coats being folded in such a way as to injure the cloth and to cause the soldiers much useless trouble and inconvenience.

Uniformity ought not to be regarded as a thing which is valuable in itself, and desirable for its own sake, but as a thing, the value of which is to be determined by reference to something else to which it stands in the relation of means to an end. Officers should not restrict their thoughts to the consideration of such questions as these: By what means may absolute uniformity of dress and equipment be attained? By what means may soldiers be trained to absolute uniformity in their

movements and exercises? How may the sphere of individual action be most effectually limited so that a regiment may be made as like a machine as possible? They should accustom themselves to go a little deeper into the matter, and to ask themselves wherein consists the utility of absolute uniformity in dress and equipment? In what way does uniformity of movement contribute to efficiency in the field? To what extent is it essential? To what extent is it practicable? Would the complete obliteration of all individual action be beneficial? What are the conditions under which many individual wills most effectually co-operate towards the attainment of the various objects of military organization?

When thus considered in relation to the objects which it is adapted to promote, it will easily be perceived that absolute uniformity is by no means the highest conceivable ideal of military organization. That absolute uniformity of dress, though advantageous in an economical point of view, is at variance with the principles of beauty, and quite destructive of picturesque effect. That absolute uniformity of movement is not only impracticable, but if practicable, would be useless for the purposes of war. That the attempt to obliterate all traces of individual action, and to treat soldiers merely as parts of a machine, is a clumsy expedient for producing a very partial and limited effect by an enormous expenditure of power.

Rule V.

Take pains to render the reasonableness and utility of every order that is issued manifest to those who have to obey it.

The essential characteristic of an officer's authority is, that it is ministerial, not autocratic. That it is the expression of law, not of the personal will of him who exercises it.* The soldiers he commands are his followers, not his servants. He is the guide who points out the path, but he does not choose its direction. The orders he gives are declaratory, not of his own will, but of a superior will, not of might, but of right. He claims obedience, not merely because he has the power to enforce it, but because what he requires is right, and according to law. So to exercise command that his authority shall exhibit this aspect to those subordinate to him, ought to be the constant aim of an officer. Both by the nature of the orders he gives, and by his manner of giving them, he should endeavour to make those under him feel the difference between law and personal desire, between the authority of a leader, and the arbitrary will of a master. He should neither act, nor should he seem to act, as if his own will were the law, and as if the orders he gives might be enforced or cancelled, as best suited his own convenience. He should not appear to be capriciously absolute, when, in fact, he is merely exercising a delegated authority, and enforcing a law which he himself is as much bound to observe as those under his command. If it be the duty of a commanding officer to require all

* Vide the Principles and Practice of Common School Education, by Rev. J. Currie.

under him to be punctual in the observance of stated times, and exact in the performance of appointed duties, it is no less imperative that he should himself set an example of punctuality and exactness.

Of course, great discretion must be exercised in the manner of fulfilling the obligations of this rule. An officer must take great care, lest in endeavouring to make the reasonableness of an order apparent to those who are to obey it, he should do or say anything which might be so construed as to be inconsistent with the obligation of absolute, unquestioning, unhesitating, obedience; which might be imagined to imply, that the duty of obedience is in any way dependent on the estimate which a soldier may form of the reasonableness of the order given him by his commanding officer. But this very necessity of exacting from soldiers absolute obedience, is the strongest reason that can be adduced for an officer endeavouring so to exercise command, that in those cases where the motive of an order is not perceived or is misunderstood, a general feeling of confidence may supply the place of a direct perception of the propriety and utility of the particular thing that is required to be done. That, however repugnant an order may be to the feelings of soldiers, however contrary to their ideas of what is right, they shall nevertheless feel perfectly satisfied that no order is ever given which originates in blind caprice or mere arbitrary will.

If an order be really useful, although its utility may not be obvious at the time it is issued, the manner in which it operates generally soon shows it to be beneficial. It is only in very exceptional cases that the value of a useful order cannot be easily perceived without explanations, and in these cases it is seldom expedient to resort to formal explanations, as a means of rendering apparent the utility of the order. To invite men to canvas an explanation, has a very different tendency from taking pains to render the connection between an order and its result obvious to their perceptions. Nevertheless there are cases when, if it be foreseen that the intention of an order is likely to be misunderstood or misrepresented, it may be expedient authoritatively to declare its motives, and to point out the end it is intended to effect.

Rule VI.

Take care that every order is expressed in concise, simple language, free from ambiguity, and so framed as to be distinct and easily understood. When an order is given verbally, the tone of the voice should be decided, and free from hesitation.

This rule expresses one of the necessary conditions which must be complied with, in order to fulfil the obligation expressed in the preceding rule. That the utility of an order may be perceived, it is evident that it must be so framed as to be easily and perfectly understood. Moreover, to inspire confidence and command unhesitating obedience, an order must be given with confidence and decision. If an officer, by a hesitating, undecided manner, shows that he himself is doubtful about the utility of his own order, and hardly knows whether it is right or wrong, it is evident that, though the order may be really perfectly right and suitable, it will fail to inspire confidence, it will

be obeyed with hesitation and reluctance, and most probably not without remonstrance and applications for explanations and directions. Presence of mind, and clearness of perception, are the qualifications on which decision and distinctness of expression depend. It is impossible for a muddle-headed nervous man to give a clear, decided order.

In manœuvring troops, clearness of tone, and proper modulation of the words of command, is a very important matter, and ought to be made the subject of persevering and systematic instruction. The voice of every officer should be carefully trained in the manner pointed out in Part I., General Principle V., page 3, of the Field Exercises, and no young officer should be dismissed from drill until the commanding officer is satisfied that he has been thoroughly initiated in the art of managing his voice, and has acquired the habit of giving the word of command in the manner pointed out by regulation. A slovenly or inaccurate pronunciation should never be tolerated on parade, and an error in accent or in the pitch of the voice should be corrected with as much care as a deviation from the words prescribed by regulation.*

Rule VII.

In giving directions respecting the method of carrying out an order, take care not to impose any unnecessary labour.

In cases where there are two or more methods of doing a thing, one easy and convenient, the other complicated and troublesome, it is very injurious to the prestige of a commanding officer and to the confidence felt in his judgment if, through carelessness or defective information, he unluckily selects the wrong method.

Rule VIII.

Before issuing an order, take care that all necessary arrangements are made for facilitating its execution.

To issue an order which cannot be complied with, unless certain preliminary details have been properly arranged, and then to punish or find fault with soldiers for non-compliance or for failures originating in these arrangements having been omitted or mismanaged, is sure to create discontent. The men will feel that the shortcomings for which they are reproached are in reality attributable, not to their neglect, but to the carelessness or incompetence of their commanding officer. Of course it is not meant that the commanding officer is personally to arrange every detail necessary to be attended to, in order to insure the due execution of his orders. But it is his duty to ascertain, both by

* One of the methods of instruction practised at the schools of musketry, termed "Communicating drill," seems to me admirably adapted for affording to officers the kind of practice requisite to acquire a good word of command, and fluency of expression in delivering orders. This exercise ought certainly to be adopted as part of the regular routine of the regimental instruction of officers.—A. C. R.

reports and by personal examination, that the arrangement of such details as he may think proper to leave to his subordinates have not been mismanaged or forgotten.

Rule IX.

In issuing a new order, take care that it does not contradict or in any way impede the execution of any former uncancelled order.

Without considerable care and adherence to method, orders emanating from different authorities, or from the same authority, but promulgated through different channels, are apt to conflict with one another. Of course it is the duty of the subordinate to regulate all matters within the sphere of his own authority, with reference to the orders given by his superior. The colonel must take care not to issue any order which in any way conflicts with those of the brigadier. The captain must conduct all the details of company management with constant reference to regimental orders. Captains ought to be especially careful not to harass their pay-sergeants by requiring their attendance at hours when their time is fully occupied in preparing returns, or in superintending the execution of orders conveyed to them through the adjutant, paymaster, or quartermaster.

But in issuing an order it is not sufficient for an officer to take into consideration orders issued by independent authorities; reference must also be made to the bearing of the proposed order on other orders issued by himself. A commanding officer, for instance, before making any alteration in the hours of parades or of school attendance, must take into consideration the whole routine of regimental arrangements. So also in calling for troublesome returns, he must take into consideration the other duties of those required to furnish them, and should either temporarily dispense with the performance of some of those duties, or else should so calculate the time he allows for the completion of the returns, as to admit of all other duties being duly performed.

The thing to be guarded against is, to require so much, that some of the things required must unavoidably be left undone. Those failures of exact and punctual compliance with orders which arise from the thing required being impracticable, are as injurious to discipline as those failures to comply with practicable orders which, through the negligence or irresolution of the officer who gives the order, are suffered to pass unpunished.

Rule X.

When by a change of circumstances, an order becomes superfluous or mischievous, do not permit it gradually to fall into disuse, but let it be explicitly cancelled. The same rule applies when a mistake has been made, and an order issued which is found to be improper or inexpedient.

Whenever an order can be neglected without inconvenience, this is a proof either that it is superfluous and ought never to have been issued, or else that through a change of circumstances, it has become unnecessary or mischievous, and ought to be cancelled. But however

mischievous or useless an order may be, until cancelled by competent authority, it ought to be scrupulously obeyed.

The obligation to obey an order in no degree depends on the utility of the thing commanded, and the injury done to discipline by neglect or wilful disobedience is the same whether the order disregarded be useful or mischievous. Moreover, whether the reason why a commanding officer suffers an order to be neglected be, that he has entirely forgotten the existence of a useless order, or whether it be, that he has not energy to enforce obedience to a useful order, the injury done to discipline is very nearly the same. The injury consists, not in the utility of the thing neglected, but in the breach of the habit of obedience.

To obviate all risk of orders being disregarded before they are cancelled, or of being acted on after they have become useless, not only all standing orders, but all orders directing anything to be done, or imposing any prohibitions, either for a definite period or until further orders, ought to be extracted from the daily order book and separately recorded. Once a month, or oftener, this record should be carefully looked over, and, if required, any orders in it cancelled or altered so as to suit any change of circumstances that may have occurred since the previous revision.

Rule XI.

So manage as never to have the laugh against you.

This rule is borrowed from Colonel Rolt's work on Moral Command,* and is illustrated by the following incident. Colonel Rolt says :—

"When stationed at Athlone in the year 1823, I, one day on parade, desired the captain of one of the companies to call four men to the front whose hair I had remarked upon the day before. I observed a sort of titter throughout the Company, which broke into a decided laugh when, on being directed to take off their caps, the four fellows presented four bare sculls. Thinking to have the laugh against me, they had cut their hair almost as close as if their heads had been shaved. The attempt to turn an order into ridicule is almost enough to try a commanding officer's amiability, but with a little effort I kept myself cool, for it occurred to me that if I got angry I should have the laugh against me, so instead of showing that I was annoyed I joined in the laugh, which then became both loud and general. After a little I said : 'Well, I am sure you are four good-humoured fellows to have afforded us all so much amusement; but although I am very glad in this way to have a laugh among ourselves, yet I should not like strangers to laugh at us.' I then asked the captain how long he thought it would take before the men's hair would grow sufficiently for them to appear in public. He replied, 'Six weeks.' I then said to the men, 'I should be quite distressed if your sweethearts were to see you in so unbecoming a plight, and, therefore, I am forced to order you to be confined to barracks for six weeks.' The four fellows looked very silly, and I do not think that they ever again tried to turn any order of mine into ridicule."

Rule XII.

In framing regulations and orders, endeavour to adapt them to the convenience of those by whom they are to be obeyed.

* Third edition, W. Clowes. London, 1842.

The first consideration of a commanding officer ought to be the good of the service; the next the well-being and convenience of those under his command. To promote either of these objects, he ought, at all times, to be ready to sacrifice his own personal inclinations and convenience. An officer of an unselfish disposition, who feels a real and lively interest in the well-being of those under his command, will find many opportunities of showing the influence of these feelings in determining the manner in which he exercises his authority. He will fix the hours of parade, the time of transacting orderly-room business, and the whole routine of the daily regimental duties and arrangements, not with reference to his own habits and pursuits, but with reference to the habits and pursuits of those under his command; as a general rule, preferring the convenience of the private soldiers to that of the non-commissioned officers, and the convenience of the non-commissioned officers to that of the commissioned officers. He will never suffer himself to be tempted to impose extra tasks, or to exact extraordinary efforts from his men, merely for the sake of reflecting credit on himself and of obtaining the reputation of being a smart officer, but in determining the kind and amount of work to be required from his men, he will be guided solely by the consideration of what he considers to be necessary for the good of the service, and to be most conducive to the well-being and happiness of the men.

The natural effect of exercising authority in accordance with those principles, will be to inspire feelings of affection and good will. The devotion of his followers is the certain reward of the self-sacrifice of a leader. But it is chiefly in dealing with individual soldiers that an officer of a sympathetic, unselfish nature finds opportunities for displaying those noble qualities and generous sentiments which kindle enthusiasm and attract love. Not only will an officer who really loves his men show the most hearty appreciation of everything that is praiseworthy in the actions or character of those under his command; not only will he do everything in his power to encourage good men, to foster good resolutions and to stimulate to virtuous efforts; he will, if possible, manifest a still deeper solicitude for the welfare of men of bad character; and if among these, there be one man worse than the others, it is for him who has most grievously erred that the deepest solicitude will be felt, for his benefit that the most strenuous efforts will be used.

Colonel Rolt thus describes his manner of dealing with a sergeant who had been sentenced to be reduced to the ranks and to receive 800 lashes for attempting to take the life of his commanding officer. He says:—

"After having watched him and studied his character for some time, I one day called him to my quarters and thus addressed him. 'Your name, I think, is Dudley.' He raised his hand to his cap and answered, 'Yes, sir.' I said, 'I have observed you for some time. Your appearance is much in your favour, you are as clean and well set up a soldier as there is in the regiment. I know your history. It would seem that no one speaks to you, nor do you associate with any one. I am aware of the cause of your being thus shunned. You once contemplated a crime of the most revolting nature—that of murder. You attempted the life of your commanding officer. You were tried, found guilty, and sentenced. All this is true, is it not?'

He touched his cap again, and said, 'Yes, sir!' but not a muscle moved. 'Dudley,' I said, 'your officers have a horror of you, but such a feeling on their part is not to be wondered at.' Still his countenance remained unchanged. 'Now attend to me, Dudley; I have watched you for some time, and I pity you. I should like to give you an opportunity for recovering your place in society, and for regaining that good character which once recommended you to the notice of your superiors. I feel desirous of giving you a trial by making you a corporal, in order that, should your conduct deserve it, I may still further promote you. Will you, Dudley,' said I, looking at him earnestly, 'endeavour to do justice to my good opinion? Do you wish for promotion?'

"The poor fellow could not answer me; his whole frame was convulsed; he cried like a child. I patted him on the back, and said, 'That will do, Dudley, you shall be in orders to-morrow.' He was accordingly promoted, first to be a corporal, and afterwards to be a sergeant, and there was not a better non-commissioned officer in the regiment."

It will very much increase the influence of an officer over the affections of soldiers if he heartily joins in their sports and amusements. This is especially the case when an officer is an adept in those sports to which his men are most devoted, and excels in those qualities of strength and agility upon which pre-eminence in these sports depends. A keen and good cricketer is almost sure to be an influential commanding officer.

The following extract from the work of Colonel Rolt recapitulates much that I have said in illustration of the twelve rules which I have had the honour of submitting for your consideration:—

"The duty of an officer is as much to conciliate as to instruct; to do all in his power to render the lives of those under his command happy, and to attach them to the service. If we disgust, although we may instruct, we do but little in forwarding the cause we have all at heart. Therefore, when practicable, conciliation and instruction should go hand in hand.

"All punishments likely to make men sulk should be avoided. Strict and impartial justice should be the leading attribute of authority. No favouritism, no tittle-tattle, should be allowed to exist, but an undeviating integrity of purpose should ever mark the bearing and deportment of him who holds Her Majesty's Commission. He is entrusted with a high delegated power. How careful should he be that such power be properly administered.

"Coercion must of course be used when coercion is necessary, but no caprice, no teasing, should ever be permitted to weaken moral influence, without which a commanding officer is but half himself. Let him indeed but possess the hearts and affections of his officers and men, and little drill will be required, little punishment will be necessary."

Regarding soldiers, Colonel Rolt says:—

"They should regard their commanding officer with feelings of respect and devoted affection. They should look upon him as their leader, their friend, their protector; they should dread his frown, they should covet his favour. His glory they should consider as their own glory. Any dishonour done to him by irregularity or disobedience, they should consider their own dishonour. In short, the fair fame of their commanding officer should be as dear to them as the fair fame of a parent."

Thus speaks Colonel Rolt. If then an officer desire worthily to fulfil the honourable function of command, let him remember, it is indispensable, that he should assiduously practice the noble virtues of self-sacrifice and of self-control.

The CHAIRMAN: Gentlemen, after the excellent, the interesting, and useful lecture which you have heard, you will desire that the thanks of this meeting be voted to Colonel Robertson for the favour which he has conferred upon us. He has mentioned the authors whom he has consulted on the subject, and I do not find among them the name of the Comte de Saxe,* with whom I trace throughout the lecture a coincidence of opinions, and whilst returning your thanks I shall use, as far as I can recollect them, the words of that great man in saying, that such a system on the part of one in command will increase not only fear and love, but a cheerful and successful obedience.

* I have read the reveries of Marshal Saxe, but it is many years ago. I did not remember that they contained anything immediately applicable to the subject of my lecture, otherwise I should certainly have referred to them with the view of obtaining materials for its preparation. I consider the coincidence pointed out by Colonel Alcock as a strong confirmation of the correctness of the principles submitted for consideration.—A. C. R., Fleetwood, 18th June.

Evening Meeting.

Monday, March 7th, 1864.

CAPTAIN SIR JOHN C. D. HAY, Bart., R.N., M.P., Chairman of Council, in the Chair.

NAMES of MEMBERS who joined the Institution between the 29th February and 7th March, 1864.

ANNUAL.

Boyle, Alexander, Captain R.N. 1*l.*
Hughes, A. C., Lieutenant 2nd Life Guards.
Hore, E. G., Captain R.N. 1*l.*

WOODEN-CASED VERSUS IRON-CASED SHIPS OF WAR.

Contributed by Colonel C. F. PARKINSON, late 70th Regt.

As it is an unsolved problem whether wooden or iron ships, or ships built of wood and covered with armour plates of iron, are the most suitable for ships of war, I trust that I may be pardoned for proposing for discussion—and I humbly hope for trial—another plan of building men-of-war. I propose having iron ships with *external* wooden casing all over them. First to the iron ship; have perpendicular timbers or planking 2 feet square firmly bolted with screw bolts (the heads counter-sunk in the timbers) to the bottom and sides of the iron ship, so close together as to be caulked between each; and with asphalted felt between them and the iron bottom, sides, &c. Over these place horizontal 8-inch planking, secured to the underneath perpendicular or upright planking or timbers by copper bolts of 20 inches long. This double planking crossing at right angles to have Jeffries' marine glue between them, and to be caulked.

The advantages of this plan are, that the copper and iron need not come in contact. No galvanic action to destroy either. By having the *iron inside* the timbers, there would be fewer splinters from that than when timber is a backing or lining to the iron sides. And by placing an iron ship thus *in*side of a wooden casing built in this manner, you can combine the *strength* and *invulnerability* of an *iron* ship with the clean-bottomed, long, sea-going advantages of a coppered and copper-fastened timber-built ship.

ON ARMOUR-PLATED SHIPS, AND THE STABILITY OF VESSELS IN A SEAWAY, CONSIDERED IN RELATION TO THE PRINCIPLE OF THE LEVER AND THE LAWS OF MOTION.

By Mr. Barrass.

Mr. Chairman and Gentlemen,

It is proposed to discuss the question of the behaviour of vessels in a seaway, and to consider that behaviour in relation to the principle of the lever and the laws of motion, and by a process of consideration based upon the conditions which actually obtain when the vessel is at sea, to endeavour to arrive at more satisfactory results than those obtained by the geometrical methods which are in present use.

When a vessel has left the dock or the quiet river (the condition under which she has been treated by her architect) and has proceeded to sea, she has entered a new life, from the passive piece of gravitation in the dock she has become, as it were, a thing of life and action, —a body in motion, and as a body in motion will, no doubt, obey those principles of mechanics, and be governed by those laws of motion which rule universal matter, as may be observed if we but search for the causes in logical sequence of investigation, from the effects as they are presented to us.

From the nature of this proposition it will be desirable to state briefly the theory which prevails at present, and for what reason exception is taken to it. To pass in review the most prominent features of those labours which have recently extended the view of the subject, and then to explain how it is proposed to account for the behaviour of vessels in a seaway by the principle of the lever and the laws of motion, and by tracing the causes of rolling, and thereby the relation which is subsisting between the cause and the effect, that it may be seen more clearly how to ensure as far as practicable a steady gun platform—a vessel that shall roll as little as possible, both in extent of angle and number of times; for now that iron will, no doubt, take the place of wood in the construction of the Royal Navy, with heavy armour plates on the sides, tending to make the vessel roll through a greater angle, it becomes a desideratum to determine the first principles involved in the cause, that control the motions of a vessel in a seaway, that we may know how to deal with the subject, and be enabled to press into our service the full benefits which armour-plating may afford.

Before proceeding, however, with this inquiry, I wish to make a few observations on the story of the backings, and the iron *versus* wood question; for it appears to me that, captivated by the term cushion, wood backing threatens to run us into a rut, whence it may take a half-century of talk, and then only, perhaps, on the occasion of some national calamity, to drag us out, while no efforts should be relaxed in

condemning the tinkering and wasteful course of building wooden vessels to be covered with armour plates.

Wood backing is quickly acted upon by the shot, it yields readily to the momentum of the blow, because it is soft, but in this very act of yielding receives the whole momentum of the shot, and so permits the whole of the work of the shot to be spent upon destruction, the wood backing being crushed and splintered up, if not at the first, at any rate, with very few blows, when both the plate and the cushion are destroyed together, and the analogy to a cushion ceases, and any conclusion, therefore, which may be drawn from an analogy which does not exist throughout the whole of the circumstances, is clearly fallacious.

Iron backing, on the other hand, is not so quickly acted upon by the shot, because it does not act by being crushed up, but acts by yielding, by deflection to the momentum of the blow, like the deflection of a railway bridge on the load passing over it (Plate XV. Fig. 1). The only difference is that the one is a yielding by a crushing action, which soon destroys the material from which it is produced, while the other is a yielding due to the elasticity which is developed by the transverse strain on the shot deflecting the plates.

If these plates are connected together in such a manner as to secure a uniform continuity of strength in every direction, this most important condition will be obtained also; that for all impacts which do not deflect the plates to such a degree as to produce permanent rupture of the fibres, the shot can only give out one-half of its momentum, because as soon as one-half of its force has been given out upon the plates, and which they have stored up, there will be immediately an equilibrium of forces between the plates and the shot, and since a lesser force cannot overcome a greater force, the remaining half of the force of the shot expires with the expiration of its velocity, when the half of the force which has been stored up by the plates reacts upon the shot or its fragments, and throws them back again. This property of throwing back the shot* has been exhibited in a marked degree by all targets wherein iron has formed an element of the backing (Fig. 1).

The matter of wood and iron backing, then, may be said to stand thus:—For moderate impacts, from which neither the plates nor the wood backing would receive injury, and where the wood backing would continue to employ the function which has been assigned to it of a cushion, then the same result would obtain as that which is sought to be obtained for heavy impacts by an iron backing, for it is immaterial in the resistance-to-penetration aspect of the question, whether the shot be resisted, or have its blow softened by the crushing action of wood backing or the elasticity of iron plates, so long as neither are injured; and, therefore, it is a mere question of which material is injured most easily, or that which withstands the greatest amount of work, and if any system is calculated to meet a heavier impact than another, it cannot be doing wrong to apply it generally.

* This occurs up to a given high velocity of shot, after which the time is too short to admit of reaction.

Fig 3

Diagram showing the present Geometrical Method of considering the stability of Ships

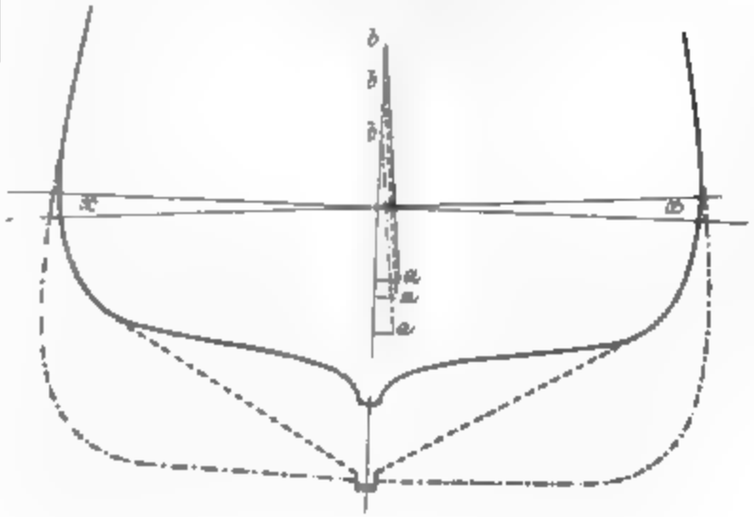
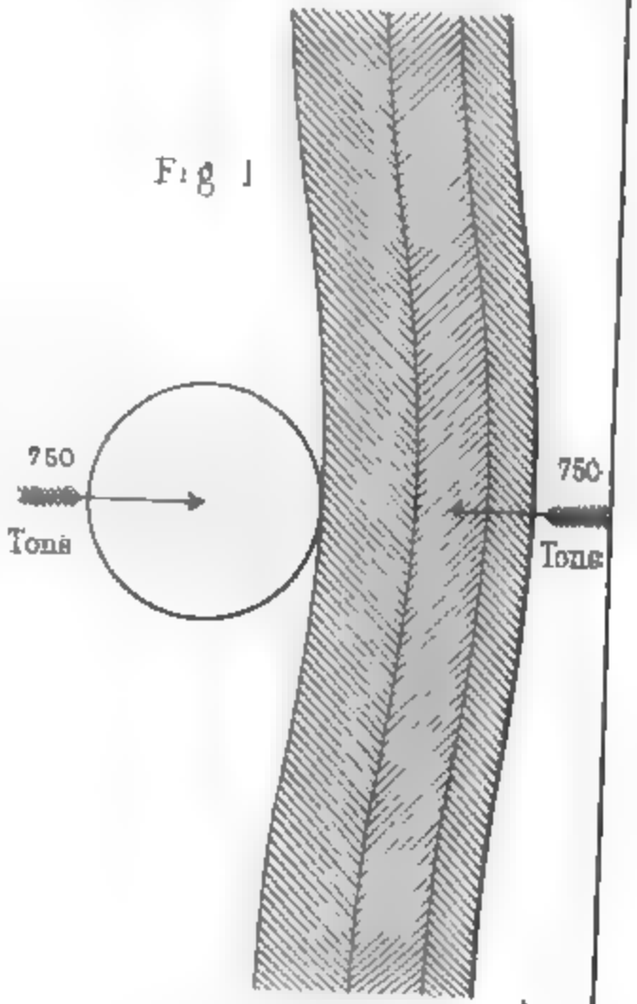


Fig 2

Orbits of Centre of Buoyancy of Rising Floor Ship

Diagram showing Iron Backing stopping the Shot when half its force has been delivered

Fig 1



47

Fig 4

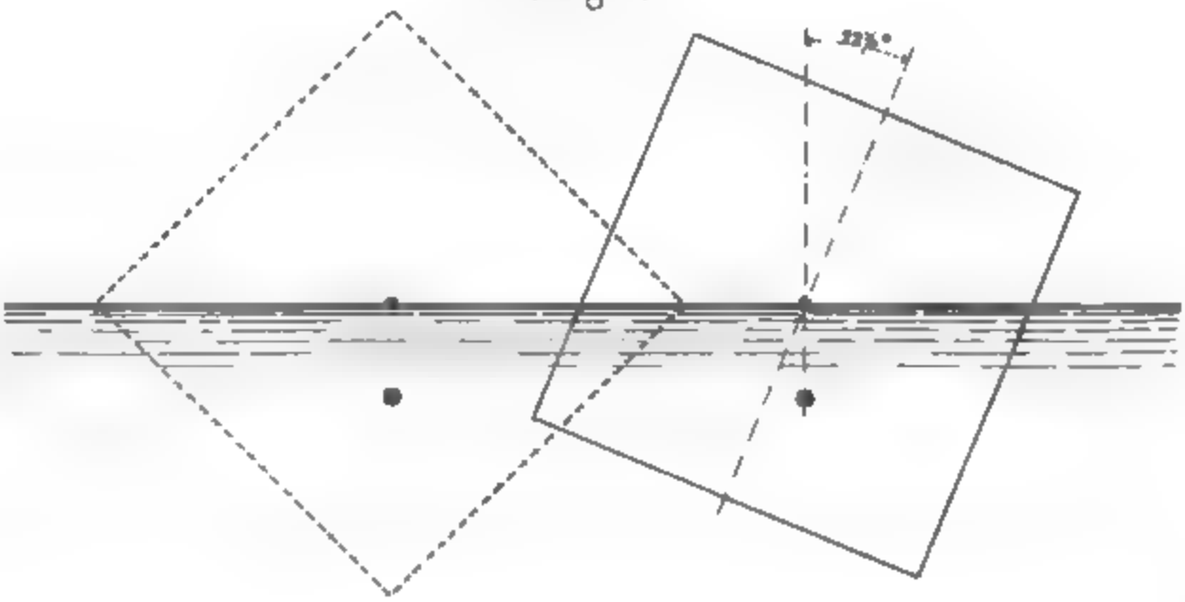


Fig 5

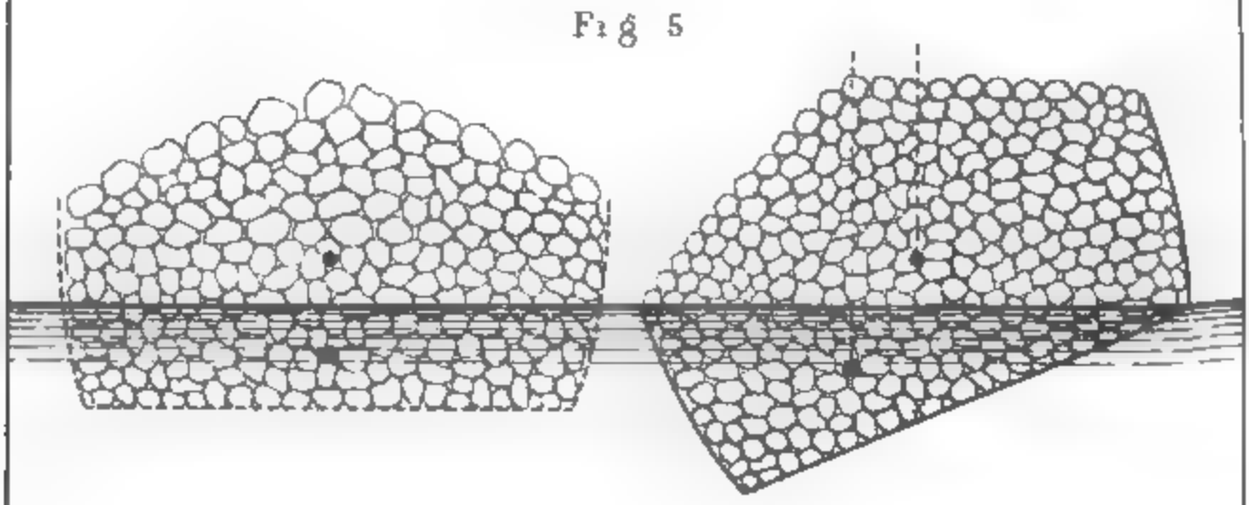
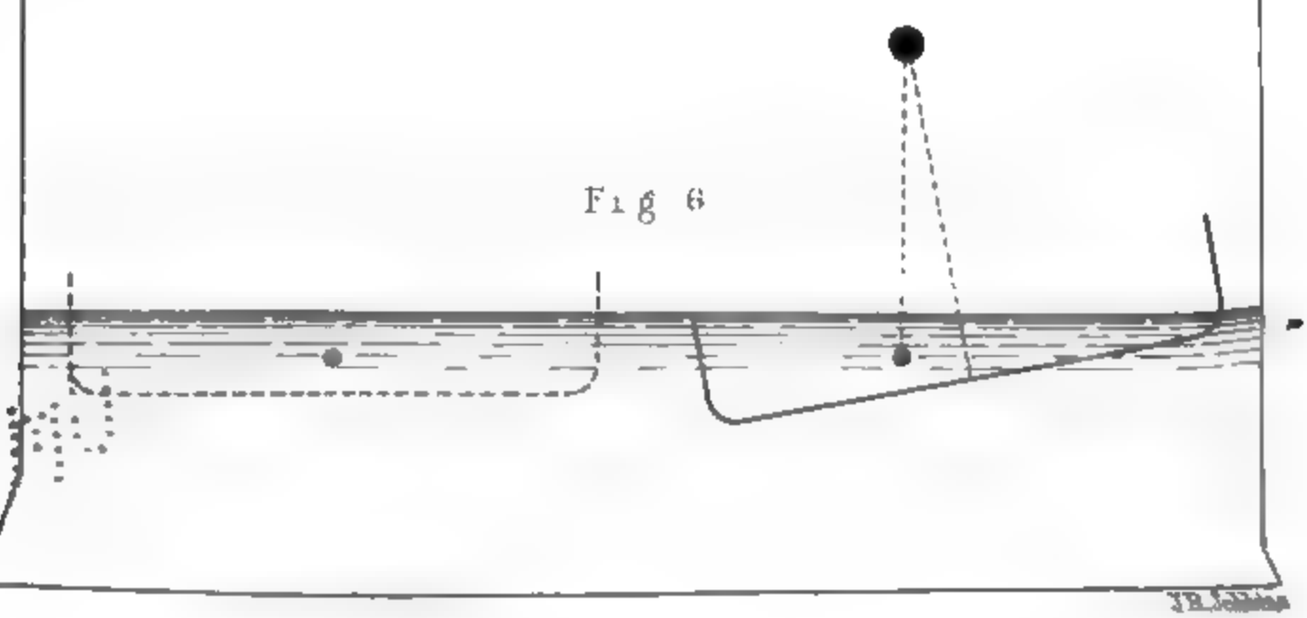


Fig 6



Turning to the iron *versus* wood question: it is said the "Prince Consort" has suffered no damage from her unlucky advent in the Channel. Having arrived in quiet water again, and the straining action having ceased, the joints closed up again, and the leakage stopped; it is made out that she shipped all the water. If a wooden built ship in herself creaks, twists, and opens her joints in a seaway, what will she be likely to do with 600 or 1,000 tons of armour plates hanging upon her sides. Consider for a moment the heaviest masses we have in motion on land, a fly wheel of a rolling mill, or a beam of a pumping engine, weighing from 20 to 30 tons only, and see the proportions and continuity of strength, that must be preserved in every detail of construction that the integrity of the structure shall not be vitiated by a weak point, and then turn to these wooden vessels, armour-plated, and reflect upon them in a sea-way, not put in motion like the almost uniform motions of machinery, but pitched about first one way and then the other, with a mass of iron of the weight of one of the Britannia tubes hanging upon their sides; and consider the details of construction which the ship carpenter has to depend upon to keep the structure together; for example, the coaks at the butt joints of the futtocks, which merely keep them in place, but give no cohesion and no transverse strength, the attachment of the beams to the sides, the knees, fastenings, and riders, fixed with spikes or bolts, which however strong in themselves, only serve to strengthen the ship by the bearing area, which the wood offers to the bolt—a soft material pressing against a hard one—the bolt pulling for itself an oblong hole in the timber long before either the bolt or the timber which it is fixing has received one tithe of its working strain. Putting these things together, and conceiving the strains that must be thrown through the beams and sides of an armour-plated wooden-built ship to pull her out of shape at every roll in a sea-way, it certainly appears unreasonable to expect that they can preserve their form and efficiency for any length of time under such circumstances, while it is clear, that if the Royal Navy is to march with the times, to press into its service the resources of modern industry and modern improvements, and is to meet modern necessities, it must be built wholly of iron or steel, but applied in such a manner as to meet its special requirements, and when that is done, I will venture to affirm that there is no property you can fairly claim for a wooden vessel, that cannot be reproduced in an iron one, with a fourfold higher ratio of efficiency.

With respect to the fouling of iron bottoms, there is in this Institution a model of an invention which seems quite adequate to remove that difficulty: viz., to fix thin planks over the bottom, and copper the planks; the planks could be well bedded in marine glue or stiff red lead paint, and secured with coach screws from the inside.

Proceeding to Stability in a Sea-way.—The theory which obtains at present for determining the stability of ships was introduced by Bougour, in 1746, as a measure of the stability of *floating* bodies, and is illustrated in its application to ships by a geometrical figure, in which the ship is supposed to be heeled over a very small amount, by drawing a new water line at a small angle with the first horizontal one,

and thus exhibiting, that in heeling over there would be a triangular prism emersed and a similar one immersed (Fig. 3). These prisms were taken as right lined figures, and the centres of gravity therefore of each triangle, at one-third of its height from the base or extreme breadth line. And from a righting moment based upon the transfer of these solids of emersion and immersion on supposed rolling, another righting moment was determined by drawing a line parallel to the inclined water line from the centre of buoyancy, and setting off on that line a distance which, when multiplied into the total displacement, gives an equivalent righting moment to that of the triangular prisms near the water line, and from this new centre of displacement (*a a a*), a perpendicular is erected at right angles to the inclined water line, and where it intersects the middle line of the ship, this point is called the meta-centre (Fig. 3, *b b b*), and its height above the centre of displacement, is the measure of the stability of vessels used in France, and on the continent generally.

This method of estimating the stability of vessels is liable, in its application, to grave errors. Ships may have a widely different form —may have a deep or a shallow section, or have a rising floor, and the stabilities of each be as wide as the poles asunder, and yet their stabilities estimated in this manner would be much about the same, seeing that at the small angle at which the heeling over is calculated, ships, at and about the water line, differ inappreciably (Fig 3).

Atwood, however, showed clearly enough in the Philosophical Transactions for 1796-1798, that the effort of a vessel to return to her upright position was due to the centre of displacement of the whole geometrical form of immersion after inclination, and the result of Atwood's theorem is multiplying the displacement or weight of the vessel into the horizontal distance between verticals falling through the centres of gravity and of displacement for the righting moment (Plate XVI. Fig 4). Atwood calculated the centre of displacement for several vessels at an angle of 7°, a process and mode of treatment he has since been so much followed in by English naval architects, as to justify its being entitled our system, though it still retains the geometry and nomenclature of the meta-centre, and the height of the meta-centre above the centre of gravity is considered the measure of stability.

There are many interesting points in the geometry with which this subject has been associated, which there is not time to introduce here, but these two statements may be taken as representing the theory of the stability of vessels as held by naval architects.

As applied to the stability of *floating* bodies in still water, the theory is satisfactory enough, but a vessel in a seaway is not a floating body only depending upon her flotation, as she was in the dock, or as she was represented on the sheet of drawing-paper by her architect; and it is in the application of this theory of floating bodies in still water, to vessels in a seaway, to which exception is taken, as not touching the conditions under which the vessel is then placed; indeed, so far from there being a true analogy between the conditions under which the theory is applied and the conditions under which a vessel is situated in a seaway,

they are absolutely reversed. Instead of the vessel being put in motion, or heeled over by an external force, with the water at rest and resisting the motion, the water is in motion and puts the vessel in motion, and that uneasiness in a seaway is not only the penalty of great statical stability, as Sir William Symonds has put it, but the penalty also of a false logic, a logic which accepts the property of the water when it is still, but ignores the same property when it is in motion, for the stability on paper or in quiescent water is derived from those very proportions which conduce to instability or excess of motion in a seaway.

Passing now to the paper on dynamical stability by Canon Moseley, in the Philosophical Transactions for 1850, the author proposed to consider the amount of work which would require to be done upon a vessel to heel her over.

If a force be applied, say to the masthead, to heel a vessel over, the force, or the mean pressure (for it will be a variable one), multiplied into the space through which the force has passed, the product will be the work done, the dynamical effect required to heel the vessel over that amount, and such as might be done by the blow of a wave, or a gust of wind; and it was proposed to measure this work by the product of the weight, and the sum of the spaces through which the centre of gravity was raised, and the centre of buoyancy lowered, the author observing that the subject had hitherto been viewed only in the point of view as to whether any given position be one of stable, unstable, or indifferent equilibrium, or that which determines what pressure is necessary to retain the body at any given inclination.

Experiments were made at Portsmouth to test the reliability of the formula based upon these considerations. In those with the triangular model the differences between the dynamical stability as calculated from the formula, and those determined by experiment, are given in the following table:—

Angle at which the model finally rested in statical equilibrium.	Angle through which the falling weight deflected the model.	Differences between the calculated and experimental results.	Leverage between the centres of buoyancy and gravity.
8°	15½°	1·29 per cent.	0·645
12½°	23½°	3·73 „	
13	24	19·16 „	
13	25	31·34 „	1·149

which shows that when the model was deflected through 15½°, the difference was only 1·29 per cent., but increased in a much greater ratio than the increase of angle of deflection, the difference between

23½° and 25° being 28 per cent., and indicating that at about 2 more degrees of deflection the difference would be about 100 per cent., and that there must be absent from the formula some fundamental element in the inquiry.

The formula takes no cognizance of the lever by which the work is done in this case. The lever is the horizontal distance between verticals falling through the centres of gravity and of buoyancy. It is clear that a vessel might have double the beam, and require double the amount of work to be done upon her to heel her over with the same amount of rise or fall of the centres of gravity and of buoyancy, while the formula for dynamical stability would make both alike; or it may be put in another light, a form of displacement might be worked out in which the whole of the work done would be expended in constituting the aqueous lever which is forming itself to resist the heeling over, with a centre of buoyancy neither rising nor falling, and perhaps with a centre of gravity falling and assisting it. Dynamical stability in still water, however, being governed by exactly those conditions which govern the statical, the one will always be in the same ratio as the other in different ships, and Canon Moseley's formula may be said to leave the subject just where it was, but under another name.

The learned author also entered into an elaborate mathematical investigation as to the time of rolling or periodic time, in which the ship is considered as an oscillating body, and its behaviour in a seaway is sought to be accounted for on the principle of the pendulum.

These considerations, however, appear to be based upon an erroneous analogy, though not so erroneous as that of Chapman, who considered the vessel as a pendulum, whose point of oscillation is the meta-centre, and centre of oscillation the centre of gravity. I believe that a little further reflection will show that the question does not belong to the department of central forces at all; indeed, I do not see how it can possibly belong to it, for a vessel in a seaway cannot be said to have any centre or axis of revolution or oscillation. It is true the centre of gravity is endeavouring to roll round the centre of buoyancy, but it is always slipping away into another position, both laterally and vertically, the radius of gyration ever varying; and to endeavour to account for the behaviour of vessels in a seaway upon such an hypothesis, seems to me to be quite hopeless, and as Dr. Woolley has truly observed in his able opening address at the Institution of Naval Architects, "the mathematical expressions for the time of rolling afford very little clue to the behaviour of a vessel. Ships in which this element is nearly, if not quite, the same according to calculation, are as wide as the poles asunder in their actual performance at sea, so that while one in a heavy sea rolls with considerable ease, another is so uneasy as seriously to endanger her masts, and in order to bring the case within the grasp of mathematical analysis, so many assumptions and limitations are necessariily introduced as to ignore the form of the vessel altogether, except just about the water line. I believe," continues Dr. Woolley, "the calculated time for the 'Vanguard' and 'Canopus' differ very slightly." You know their relative behaviour. Their solids of immersion at an angle of 7° are as

5 to 1 with a breadth of 57·6 feet in the "Vanguard," and of 51·8 feet in the "Canopus," when heeled over, and with this greater breadth and solid of immersion (and, therefore, the probability of the whole geometrical form of immersion partaking of that character, and giving a greater lateral traverse to the centre of buoyancy) we seem to have indicated to us why the "Canopus"* rolled slowly and easily, while the "Vanguard" rolled very much more quickly and uneasily, and why those very properties which give great statical and dynamical stability in quiet water, upset all calculations as to periodic time, and produce a reverse result as to stability when the vessel becomes a body in motion actuated by the waves.

It will be desirable now to review briefly those hypotheses which have been appended recently to this subject, namely, the supposed motions of the fluid particles in waves, and the supposed configuration of the waves to some mathematical curve, and the supposed periodic time of transit.

With respect to the motions of the fluid particles in waves. If we think upon the transmission of force as illustrated by the old experiment with elastic balls, and bear in mind the mechanical property of water of being competent to pass a great force through its particles, and combine these with a consideration of its being under the influence of the law of gravity in the vertical direction, then the whole phenomena of wave motion is easily explained. Wave motion is the motion of a force only passing through the particles. The wind blowing in a horizontal direction communicates its force to the fluid particles, but by their close contact and resistance to receive motion in that direction are driven up, the horizontal force exceeds the gravitating force, until they have been driven up high enough to balance it and pass it on, and so giving direction to the wave force. The direction in a gale being that of the wind, in a calm that of the beach,—the horizontal line of least resistance to its transmission; but in a cross and troubled sea, or behind piers and breakwaters the forces meeting, dividing and playing through the particles in sudden and ever varying movement, sometimes two great forces meeting, and the resultant producing a much higher wave than usual, and with the fall of the wave all trace of it has vanished from the spot; where we saw the huge wave we now see comparatively smooth water, for with the fall of the wave, the vertical force which was the resultant of the forces meeting, is again divided up and sent into other places to repeat the operation, and that which has sometimes been considered an optical illusion, becomes, when accounted for, a solemn and instructive fact.

The solitary wave traversing the ocean, is a force which has received its direction and amount at a distance from the place in which it is met, it passes through and leaves the particles in the same horizontal position in which it found them, and without having impressed its hori-

* Captain Fishbourne, R.N., who revised this paper for Mr. Barrass, after his departure from England, states that "'Vanguard' rolled both *deeper* and faster in a seaway than 'Canopus.' The mistaken views arose from overlooking the differences of the amount of vis viva, arising from the two forms: this vitiates all calculations." —Ed.

zontal motion upon them; and if the wave be so high that the ship breaks the contact of the particles, then, like the last ball in the experiment mentioned, the last particles take up the motion of the force and momentum, and a blow is the result.

The motion of fluid particles, then, in wave movement, is simply an up and down one (as sailors have long considered it to be), but having a tendency to slide down the side of the wave, according to the resultant of gravity and fluid pressure, and the time there may be to bring these forces into action.

The behaviour of the vessel, therefore, cannot be influenced by the behaviour of the fluid particles in wave motion, because they are governed by the same laws and conditions as the vessel herself, she riding freely up and down and over the wave, but having a tendency to slide down the side of a wave in the direction of the resultant of gravity and fluid pressure. Captain Fishbourne informed me that this tendency was most distinctly felt on board rising floor ships, jerking bodily down when on the side of a wave. An inspection of the diagram will explain it as being due to the parallelism of the floor of this class of vessel, with the surface of the wave when on the side of it.

How far the wave forces may pass on so uniformly, both in amount of force and period of time, as to present the repeated configuration of a geometrical curve, and to what extent any theoretical conclusions could be based upon such considerations, your own practical experience will have informed you.

The proposition of Mr. Froude, however, calls for a more detailed review.

The author, on the strength of some experiments with a floating plumb bob, proceeds into a laborious and elaborate mathematical investigation, which results in proposing what appears to be more a question of mere ballasting than a question of the science of naval architecture, viz., to manage and control the behaviour of vessels in a seaway, more by the disposition of ballast than by the form of the ship, stating that he is satisfied if you take two ships differing as widely in their forms as those of the "Albion" and "St. Vincent," and load them so that they have the same periodic time in still water, they will perform almost identically when rolling in a seaway, and that all ships having the same periodic time or period of natural roll when artificially put in motion in still water, will go through the same series of movements when subjected to the same series of waves, whether their stability in still water be due to breadth of beam, or to deeply stowed ballast.

The experiment with the floating plumb-bob (Fig. 6), and which the author considered as exhibiting his fundamental law which governs the motion of a ship on waves, was made with a small cork-float about four inches diameter, like a life-buoy with a mast fixed obliquely in one side of it, with its apex perpendicular over the centre of the float, and having a small plumb-bob suspended from it; and because the plumb-bob remained central to the float when it was disturbed by waves, the author proceeded to consider the conditions of a floating

body to be the same as surface fluid particles, and to assign them to specified dynamical conditions which the position was supposed to impose upon them.

It will be observed that a float with a loaded mast fixed in one side of it becomes in disturbed water a variable lever of the second order with respect to the fluid pressure to move it, on the transit of a wave; the power of the wave water to move it, being directly as its pressure when under the mast, but as the wave passes on under the float, the leverage of the fluid pressure to move it, is increasing, until when the mean pressure of the wave has arrived at the opposite side of the float to that in which the mast is fixed, the leverage of the water to move the loaded float is increased 100 per cent. to move it quicker or in half the time at this period of the wave transit, than when it was underneath the mast, so that the cause of the plumb-bob remaining central to the float in disturbed water is a mechanical one, and the mast has a tendency to make two complete vibrations for one wave transit, and when the flexibility of the cork and mast are considered, the variability of the leverage of the disturbed water, and it not having a rigid fulcrum to work upon, it is not to be wondered at, that the masthead flew about, and did not give the plumb-bob time to do otherwise than to remain central to the float.

I am far from wishing to depreciate Mr. Froude's labours; indeed, I am ready to acknowledge having been much instructed by them; but from the premises to the conclusion and throughout all their argument, they appear to me to be either illogical or in absolute error. They start upon an experiment which I have shown to have been misinterpreted, and are continued upon assumptions which are only permissible because they are not absolutely impossible, whilst strangely enough, they end in but one practicable measure, that of favouring a maximum beam; so that, taking the author's conclusions on his own terms, he ends as he began, with recommending that very condition which was known to give great statical stability in quiet water, and the instability in a seaway of the sailor. As to the idea that a steady vessel can be made out of a bad form, or that the form is immaterial, and that in the case of an armour-plated ship (with the heavy armour plates on the extreme width and the engines and boilers nearly on the extreme bottom) the effects of these weights on the motions of the vessel can be modified or neutralised in a bad form of vessel by a few tons of ballast placed wherever you like, I must confess that, to my mind, the proposition seems an absolute delusion.

I now proceed to explain how to account for the behaviour of a vessel in a seaway on the principle of the lever and the laws of motion.

When a vessel is rolling in a seaway, a lever is formed on each side from the resultant upward pressure of the fluid, the centre of buoyancy has acquired a position in this rolling over which gives it a command—a leverage to move the vessel, and to cause the motion of rolling in disturbed water. That is to say, though there is not a rigid fulcrum, in the usual significance of the term, but the upward pressure of the particles are alternately becoming the power applied, and the

fulcrum, as the one exceeds the other on the rolling of the vessel from side to side; and the distance, therefore, which the centre of buoyancy traverses from side to side on rolling will be a leverage (Fig. 7, 8, 9, Plate XVII) presented to disturbed water to put the vessel in motion.

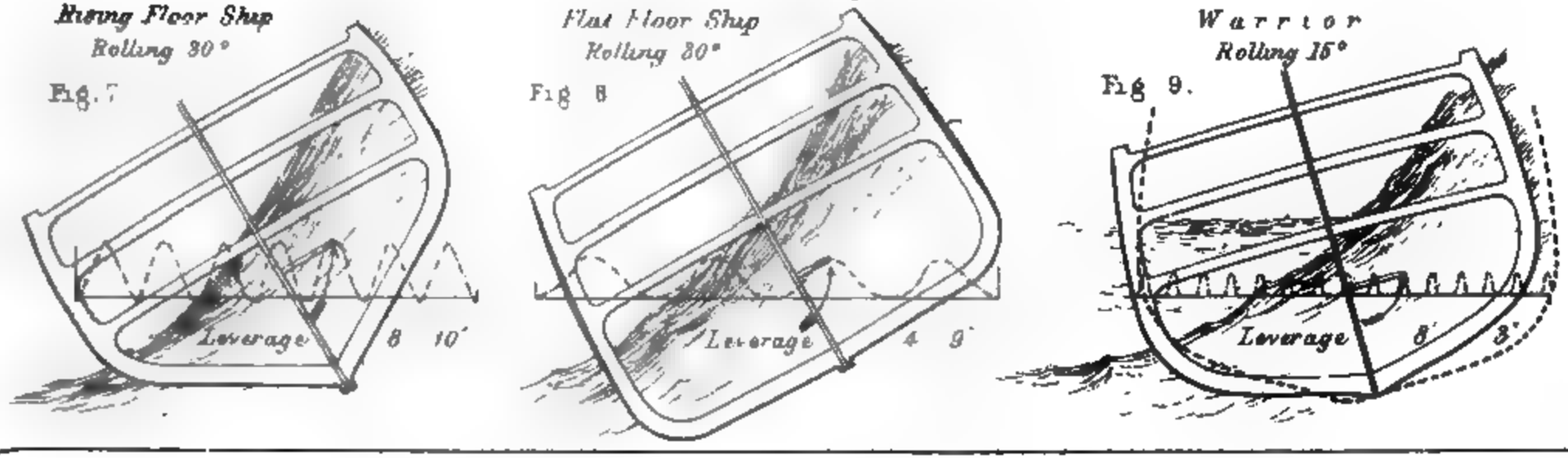
In no department of the inquiries which come before this Institution have the labours of Captain Fishbourne been more fruitful of useful results than in this upon which I have the honour to address you, and from him I have to acknowledge receiving valuable practical assistance and counsel in the preparation of this paper. It was to his published lectures on naval architecture in 1846, that I owe the knowledge of the views of the "Naval Architect" not meeting the requirements of the fighting sailor, and the inducement to look into the matter.

I was not aware, however, that Captain Fishbourne in subsequent papers had introduced such a mode of viewing the subject as referring the influence of the passing wave on the vessel to the principle of the lever, or I should have left the subject in his hands; but having embarked in it, I will state the results. My conclusions, it may be observed, were drawn from small experiments and a process of reasoning. Captain Fishbourne's conclusions are based upon practical experience at sea, and demonstrated by the facts and figures given in the following table of recorded results of the actual performances of vessels of the Royal Navy, and which prove beyond doubt and without exception of example, if even it could not be proved logically and mechanically, that a beam relatively great to the depth of displacement, is that very condition which goes far towards making a rolling ship in a seaway.

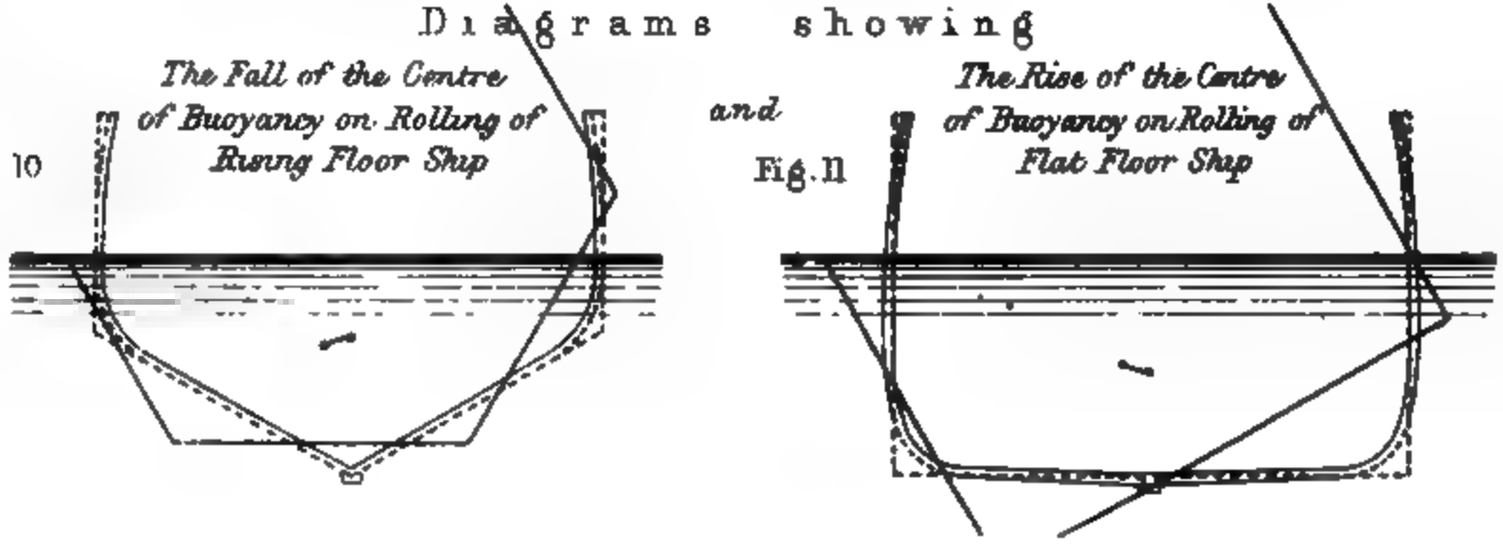
Table showing the relation between the beams of vessels and their behaviours in a seaway :—

Name of Vessel.	Half breadth.	Depth.	Difference.	Angle rolled through.	No. of times per minute.
Albion.	30′ 0″	24′ 4″	5′ 8″	49°	13
Rodney.	27′ 0″	24′ 8″	2′ 4″	27°	8
Queen.	30′ 0″	25′ 3″	4′ 8″	20°	7
St. Vincent.	26′ 9″	25′ 3″	1′ 6″	13°	5
Trafalgar.	27′ 6″	25′ 3″	2′ 2″		1
Superb.	28′ 6″	24′ 7″	3′ 11″		3
Canopus.	25′ 6″	23′ 10″	1′ 9″		2
Hecate.				10°	8
Antelope.				5°	4

Diagram showing the Rise and Fall and the Leverage of the Centre of Buoyancy in a Seaway of



Diagrams showing



If anything more were wanted to prove the truth of the argument, it is supplied in the fact of a vessel rolling more when light than when laden, for it must not be supposed that the water "per se" has a greater power of flotation then. The mind must not admit the idea that because the vessel is lightened, the water will necessarily have more command over her without a mechanical cause other than its buoyancy, for just in proportion as the vessel has been lightened, so has the floating power been reduced also; and if a vessel when lightly laden is rolled about by a sea more than when it is heavily laden, it must be due to the floating power having then a greater proportionate command over her, a greater leverage with a lesser weight to put her in motion when light than when laden.

Now, if we apply the present theory to the same vessel when light and when laden, we find that though the centre of gravity has been raised by her being lightened, the meta-centre has been raised also, so that virtually the theory would give the vessel the same stability, when it is so well known that the contrary is the result in disturbed water, and the mechanical cause of it seems clear enough. If a vessel has been lightened on her voyage by a foot of her draught, the mechanical power of the waves to put her in motion would be the same as if her draught had been preserved, and two feet had been added to her beam. If she were lightened by two feet of her draught, the mechanical equivalent would be as if four feet had been added to the beam; and if she now draws three feet of water less than when she started, the waves will have the effect to put her in motion as if six feet had been added to her beam.

The simple fact appears to be this: that the course of naval architects has been, is, and I fear will be, until they are shamed out of it, to consider the water and vessel at rest only, allowing, as it were, the water to have the power to float the vessel when at rest, but ignoring the power of the water to put the vessel in motion if it be disturbed, forgetting that the conditions are reversed in passing from quiet to disturbed water, and that what was the lever in the first case to resist the heeling over, becomes in the second the lever to put her in motion.

Let me be understood as taking no part with those who consider that a large amount of ignorance prevails amongst the professors of this science, knowing that the highest attainments are requisite for its pursuit, and remembering the channels which a long current of thought and treatment tend to deepen and render difficult of being diverted afterwards.

But it does appear that they committed an oversight in letting their theory get into such a rut, while they have been somewhat unwilling for any one to help them out of it. Now, they might be very well sure that if their theory was worth anything, and rested upon a foundation which they relied upon themselves, and could communicate to others, and be relied upon by sailors, their views would not be questioned, and my appearance here would be inexcusable. But what do we find? One professor for a flat floor, another for a rising floor, one for a barrel bottom, and another for a cigar shape altogether, while one would always have a clipper section totally irrespective of first con-

siderations; and whether the vessel was simply to sail fast or to carry a broadside armament, one for a full fore body, and another for a full after body. The former not having a reason of his own, goes to nature for one, and cod's heads and mackerel tails become the standard for the forms of ships, and not unfrequently a small model dressed down here, and shaved down there, until it pleases the eye, is the theory employed. Is it to be wondered at then, seeing these things, that this subject engages the attention of inquiring minds, whether they may belong to the profession or not?

But the fishy analogy is somewhat amusing, inasmuch as a fish wags its after body and tail to propel itself quickly, and if any analogy subsisted in the view, the ship should wag her after body and tail also, but as the ship does not do that, the forms of fish are no clue as to what ought to be the forms of ships. If we endeavour to interpret nature on first principles, it may be that since a fish propels itself by a muscular exertion from the shoulders to the tail, and its power, therefore, to work the after body being inversely as its length and directly as its depth and breadth, nature tends to produce that muscular development which enables the fish to fulfil its functions on mechanical principles, and it is supplied with a good leverage and quantity of muscle where it is wanted—at the shoulders.

I have now to propose the consideration of a vessel in a sea-way as a body in motion, and as a body in motion subject to those laws of motion which are governing all matter in motion.

When a vessel is rolling in a seaway, the centre of buoyancy in passing from side to side, may rise or fall in doing so, and the centre of buoyancy being the centre of support, if the centre of support falls on rolling, then the accelerating force of gravity will come into action, tending to continue the rolling (Figs. 10, 11). Thus the centre of gravity of the vessel is rolling through an arc, and the versed sine of that arc may be taken as the measure of the accelerating force of gravity to continue the rolling; but if the vessel in rolling, has, as it were, lost her point of support, then the vessel is permitted to continue the rolling, and the amount of the accelerating force of the gravity of the vessel to continue the rolling, may be measured by the versed sine of the arc of the centre of gravity, plus the versed sine of the arc of the centre of buoyancy; and thus if the centre of buoyancy falls, it permits the vessel to roll through a larger angle than it would do, if the centre of buoyancy rose with the rolling, and presented a retarding force to the motion.

I am doubtful whether I may have succeeded in conveying the proposition to your minds; the subject is a subtle and difficult one, and I have not yet been able to devise a moving diagram to illustrate it, which it would require to do, to demonstrate it clearly; but I think if you will conceive, that if a vessel's geometrical form of displacement is such, that in the act of rolling, the water surrounding her has by the action of gravity given out a force—a resultant fluid pressure at a greater height, produced a dynamical effect, a force moved up through a given height, and that the effect upon the vessel is the same as if an hydraulic press had been acting on each side of the vessel at each

roll, and thrusting out its ram with a pressure equal to the weight of the vessel, and through a space equal to the rise which may be given to and at the centre of buoyancy, then you will form some conception of the enormous power which a vessel may extract from the subtle element in which she is rolling, if you but give her a geometrical form which will enable her to do so, and make her a steady vessel.

Thus, suppose the displacement of the "Warrior" to be 10,000 tons, that she is rolling ten times a minute, and that if by flattening the floor, the centre of buoyancy was made to rise six inches higher than it does, or not to fall so much by that amount; then multiplying these together, and by 2240, the number of pounds in a ton, we have the dynamical effect of 224,000,000 lbs., raised one foot high per minute, and dividing by 33,000, we have a power equal to that of 6,787 horses, that would be given out by the gravitating force of the adjacent water, to keep her a steadier vessel, if her geometrical form of immersion were such, that in the act of rolling, the resultant fluid pressure, the centre of buoyancy, rose up against the roll six inches more than it does.

Referring to the diagrams (Figs. 7, 8, 9) in illustration of the point, they show a rising floor vessel, a flat floor vessel, and the "Warrior," one-sixteenth the full size, all of the same beam and draught. In the rising floor vessel, the centre of buoyancy falls 8¼ inches through 30° of roll, when it suddenly commences to rise, as shown by the orbits of the centre of buoyancy in the diagram (A A Fig. 2). This indicates that vessels of this form will be easily set in motion, roll through a large angle, and quickly, but will be suddenly arrested near the termination of each roll, checked with a jerk, as it were, enough to throw the masts overboard, and then as quickly sent back again, for just as the centre of buoyancy has commenced to be effective to control the rolling, it has then acquired a great leverage to return the roll quickly.

A phenomenon of frequent occurrence also bears upon the point. When quick-going steamers are passing over shallows, waves are raised at the bow and stern by the pressure from amidships, the vessel then loses a portion of her displacement amidships, but gains it forward and aft by these waves which are raised there, and in proportion as the buoyancy has been increased forward and aft, and lost amidships, the vessel has been made temporarily of a peg-top form, from losing the displacement where the floor is flatter, the centre of buoyancy falls on rolling, and, therefore, she rolls easily.

The incident related by Sir Heron Maxwell also might be mentioned, that when the "St. Vincent" was perfectly steady, the "Albion" was lurching over in a quiet sea in the Bay of Biscay, and shipping 100 tons of water through her lower ports, to the affright of the Admiral Commanding.

The new armour-plated frigate, the "Valiant," judging from her section, will be a second "Albion," though perhaps not quite so bad.

In the flat floor vessel, the centre of buoyancy rises 9½ inches through 30° of roll and still continues to rise, as shown by the diagram (B B Fig. 2). This indicates that vessels of this form will always be

steady, roll through a small angle, and slowly as well, because the centre of buoyancy is always exercising a retarding force to the roll of the vessel, while the form of displacement developes only a small lever to induce motion in disturbed water.

Naval architects will tell you that this will make a most unsteady ship, from the bodily rise and fall of the centre of gravity which the rise and fall of the centre of buoyancy may give, or which the form of immersion after heeling over may give. An argument which not only appears incorrect, but it is the veriest rubbish, as if the bodily rise and fall of the centre of gravity as exhibited by their geometrical figure in still water can be compared to its being thrown and pitched about in a seaway ten times as many feet as the drawing will exhibit inches. Besides the centre of gravity is an abstraction, while some of its items might be so situated in the ship as to take away all grounds for this argument. The stability of a nearly complete homogenous cylinder wholly depends upon the bodily rise and fall of the centre of gravity.

Taking even a common sense view of the matter, apart from theoretical grounds, does it not appear reasonable to expect a vessel with a flat floor to be steady in a seaway, seeing that, on her rolling, a large nearly flat surface is pressed downwards at a maximum depth, and therefore exercising a maximum effect to resist the motion; while in a circular or peg-top form, that resistance to the motion is lost in proportion to the vessel partaking of those forms, when instead of a nearly vertical pressure at a great depth, it becomes more of a side pressure at a lesser depth, and for both reasons not so calculated to resist motion in a seaway as a flat-floored vessel.

In ships of an intermediate form, their behaviour in a seaway will be of an interesting nature. The centre of buoyancy of the "Warrior" neither rises nor falls within a roll of 15° (C C Fig. 2). This indicates that vessels of the "Warrior," "Canopus," and all those forms approaching to or possessing the barrel bottom, will roll through a lesser angle than the peg-top class, but through a greater angle than the flat-floor class, their motions will be much easier than the former, but not easier than the latter.

Recapitulating, in conclusion, the results which flow from these considerations:

1stly. The present method of treating the stability of a vessel as that of a floating body in still water, is illogical and does not touch the question of the stability of a vessel in a seaway, inasmuch as in still water it is the water which is resisting the heeling over on the application of an external force, while, when the vessel gets into a seaway, the conditions are reversed, the water is then in motion and is putting the vessel in motion, without the presence of and without any reference to the force by which the heeling over was effected in still water, and therefore that form of body which would offer the greatest stability in quiet water, will present it to put the vessel in motion when she has passed into disturbed water.

2ndly. The centres of gravity and buoyancy ever moving about with every varying condition of loading, trimming, pitching, rising up

and falling down, and rolling in a seaway, the problem can scarcely be considered as belonging to the department of central forces, and therefore any investigations based upon the principle of the pendulum cannot but be questionable, if not erroneous; while if we consider upon what actually does take place of the centre of buoyancy forming a lever of the second order of which it is the power, the centre of gravity, the weight, and the fluid pressure on the other side the fulcrum, and that all these are in motion and with a centre of buoyancy, either rising or falling, either using or losing the power which it may command. It would appear that the principle of the lever and the laws of motion are logically applicable to the case, and though it will still be beyond the grasp of mathematical analysis, at least so far as to determine absolute quantities, they are sufficient to account for the behaviour of vessels in a seaway.

3dly. That for fighting ships where accuracy of fire is necessary, and therefore a steady gun platform, the floors should be flattened first, and then reduce the beam as much as is practicable.

I now submit to your judgment how far these observations coincide with your practical experience on board ship at sea, and how far you may consider the course indicated to be calculated to ensure you the full benefits which armour-plating may afford, and that its utility shall not be nullified by a bad form of vessel, and if, in making these observations, I have at any time spoken with more assurance than my experience and these circumstances would warrant, I trust you will attribute it to the instinct to clothe the language of a firm conviction in the language of earnestness upon a serious and important subject, rather than to forgetting the assembly which I have had the honour to address.

Mr. Michael Scott, C.E.: To my mind this is a subject of such intense difficulty that one cannot speak upon it without some consideration. If the discussion were to be adjourned I might perhaps be prepared to make some observations upon the subject. The paper has been to me very interesting, but it is quite obvious from its very nature that it is difficult to follow the argument, or to criticise any of the statements made in it, without some time for consideration. However, there are one or two points that I might notice. One is with respect to the form of the fish as distinguished from the form of a vessel. The fish is a wholly immersed body; the ship is only partially immersed. I quite agree with the author, so far as I understood the paper, that it is possible to draw very erroneous conclusions from the form of a body wholly immersed, such as that of a fish, if it be intended to apply it to a vessel which is floating on the surface. Another point that struck me was, with respect to the motion of water in a wave. We recognise waves of different characters. In one wave, the motion is what the author has described, very much to leave the particles in the same horizontal position that they were in before disturbance. In another form of wave it is not so; the water is absolutely in motion, and it exerts very considerable power on any body that is floating on its surface at the moment. I do not know that I quite understood the author's criticism on Mr. Froude's theory. I

heard Mr. Froude give an explanation of that theory, and it appeared to me to be very satisfactory. But it is confessedly a subject of such difficulty, that there is room for a wide divergence of opinion; and I think more might be learned from the practical experience of naval officers, with respect to vessels of various forms, that would be more interesting to this Institution than anything I could say upon the abstract question of theory.

Captain E. G. FISHBOURNE, R.N., C.B.: I suppose I ought to make some remarks, as I have been alluded to, and more especially as the last gentleman who spoke seems rather disposed to affirm the correctness of the views of Mr. Froude. The tables on the wall are founded upon actual experiments, I would rather say upon observations than experiments. ["Table showing the influence of beam upon the behaviour of vessels in a sea-way."] These ships were under similar circumstances when the angle of roll was taken. The "Albion" rolled 49°; the "Rodney," 27°; the "Queen," 20°; the "St. Vincent," 13°. In the next column you will observe the number of times that they rolled in a minute: the "Albion," 13; the "Rodney," 8; the "Queen," 7; the "St. Vincent," 5; and so on. Now the proposition of Mr. Froude is, as stated in the paper:—You may take any description of vessel, and by the adjustment of the weights you can correct any defect of rolling. That is to say, if she should roll too quickly, you can adjust that by raising the weights, so that she shall roll more slowly. But as a necessary consequence of so doing, she will roll through a larger arc. If she rolls too slowly and through a larger arc, then you can lower the weights, and the consequence is you will reduce the arc, but you will increase the rapidity of the roll. Now, in the case of the "Albion," you have got two irreconcileable things: she rolls through the largest arc, and she rolls the most quickly. Now put in practice Mr. Froude's principles. Look, for the moment, simply at the fact of her rolling 13 times in a minute. That is too fast, so you raise the weights, and, immediately, that which is already too great, viz., her depth of roll, will at once be increased. The real history of the matter is simply this, as is too much the case at the present time, mathematics and common sense, or practical knowledge, have been divorced. I have a great respect for mathematics, but it is only when they are in good hands. Mathematics are very simple in operation; the steps are very short, and any person may be taught to take all the steps; but the great difficulty is, in the application, or having got your answer, to know how to read it. Unfortunately, without a practical knowledge, or without common sense, as a rule mathematics cannot be satisfactorily applied or understood, which is the case in the present instance. Mr. Froude has made an experiment in a tin dish; to this exceptional kind of experiment he has applied his mathematics, and he has got a result which really means nothing. Now, if the statement respecting the rolling of these ships be true, and I can have no doubt about its truth, for the officers had no theory to support,—(the signal was made by the Admiral, "Take the number of the rolls and take the angle of the rolls," and they were taken and recorded, and the result returned to the Admiralty)—if that statement be true, and

you cannot for a moment imagine that it does not represent existing facts, then if you apply this theory of Mr. Froude's, you at once see its absurdity. It reminds me of a story that I once heard of a boy who demonstrated that the square of the hypothenuse of a right-angled triangle was equal to the sum of the square of the other two sides. He was not very bright; he learned to get the orthodox proof off by heart, but he drew a figure that was altogether different from the proposition he had to prove. He went off very glibly with his proof, then said, "Well, I have proved it, but I don't believe it." Now, I believe, if people were as honest as that boy, we should have such an acknowledgment with respect to many results; that there is not, I believe, simply arises from the absence of practical knowledge of the subject. Architects have undertaken to design and to build ships without practical knowledge of the subject. They ignore that altogether, while, on the other hand, sailors have been inclined to go in the opposite direction, and say, "Because I have been at sea and have got practical knowledge, I do not need any architectural knowledge; I do not need to understand the principles of mechanics, nor do I need to understand the theory of naval architecture." I believe the truth is, as Mr. Scott said, we want a combination of the two things, mathematical knowledge, and common sense, or practical knowledge applied to that. I believe this to be a very important question, and that it has been treated very satisfactorily by Mr. Barrass. I am quite satisfied that if anybody will take his paper and examine it quietly, he will see it is simple and plain. It is not a subject that is at all difficult, put in the way it is. It has been treated in a plain, common-sense way, which anybody of understanding may comprehend if he will only give himself a little trouble and very little time to study it. I am quite sure that if that be not done, and we are to be led away by the great mathematical talents and knowledge of such persons as Mr. Froude, we shall be landed in the greatest absurdities, and our ships will be utter failures. I believe we have already gone a long way in the wrong direction, and I consider the results will be very serious. Many of the points in Mr. Froude's theory it would be hardly fair to notice here, because they have not been referred to in the paper; but those which have been brought forward I have remarked upon, as showing what has been stated, that he has overlooked many of the circumstances of the case. Therefore he has applied his mathematics without considering many of the main points of the question. Mathematics are very powerful, something like a dentist's instrument, which if not rightly applied, pulls out the wrong tooth; and then the dentist has to convince the patient that he has not got the tooth-ache. Considering that Mr. Barrass is not a naval man, and has not been to sea professionally, this paper is altogether a very creditable production.

I might make a remark upon the paper from Colonel Parkinson that was first read. He proposes to put wood outside. The main object that he seems to have for this is merely for the purpose of coppering. It is a great desideratum to be able to copper a ship. A plan has been proposed by Mr. Grantham, and I think it is an excellent proposition.

There is another point in the paper which did not seem to be dwelt upon, but which I think is perfectly sound. It is to put the wood on the outside of the iron, rather than the iron outside the wood. A great point to be arrived at is to take up the intense velocity of the shot on first striking. By doing that, the shot will not penetrate the iron; but if you allow the shot to come in contact with the iron when it is at its highest velocity, it will penetrate it, and penetrate it more rapidly in proportion to the greater velocity and the greater weight of the shot. I believe wood acts more truly as a buffer when it is on the outside of the iron than when it is inside. As for the wood being destroyed by shell or by shot, that is quite immaterial, so long as the shot does not touch the real fabric of the ship. It is a complete iron ship, and then the wood is put on outside. Wood is easily repairable, and if it be destroyed it is just what you might expect. You do not expect to go into action and not have your ship knocked about; and not the ship only, but your heads too. As Sir George Sartorius said the other evening, we must be content to take our hats off, and let the shot go through.

A suggestion has been made to me by Sir Frederick Nicolson respecting Mr. Froude's system of raising and lowering weights. I gave Mr. Froude the benefit of the possibility of moving weights; but the fact is you cannot move any large weights in a ship. Take the weight of the "Warrior," a 6,000 ton ship. The weight of the hull must be something enormous. It cannot be less than three or four thousand tons. Just imagine what a large weight would be required, and what a distance you would have to raise it, to make any material difference in that ship! Why, the thing is utterly impracticable. In the remarks I have made I gave him the benefit of the possibility of doing it, but I say it would be impossible to do it from the nature of the problem, from the limitations that you are necessarily involved in in connection with the requisites of a man-of-war.

The Chairman expressed the thanks of the meeting to Mr. Barrass for the very interesting paper he had read. He had no doubt it would be of great advantage to the public service.

LECTURE.

Friday, April 15th, 1864.

LIEUTENANT-COLONEL T. ST. LEGER ALCOCK, Vice-Chairman of the Council, in the Chair.

MILITARY GYMNASIA.

By ARCHIBALD MACLAREN, Esq., The Gymnasium, Oxford.

WHEN I had the honour, some time ago, of reading a paper on this subject to the members of this Institution, I endeavoured to show the value of a gymnastic training to the soldier.* I desire to-day to do myself the honour of describing the material means which I have found it necessary to employ, and in many instances to devise, for the purpose of carrying out my system of training, which means are now being provided by the military authorities with a completeness which leaves nothing to be desired.

With the first conception of the leading features of the system, I perceived that the construction and fitting up of proper gymnasia would be a *sine quâ non*, indeed must be viewed as an integral part of the system itself; and as in this respect it differs from the military systems of other countries,† which are entirely carried on in the open air, I will, with your permission, mention a few of the advantages arising from the organization of such schools.

The first of these is, the value which regular and consecutive instruction possesses over irregular practice.

In the cultivation of the bodily powers it is quite necessary that the instruction should be progressive—that to-day's lesson should, as it were, be taken up to-morrow and carried a little farther on, and the next day and the next a little farther still, and so on to the end of the course. When thus administered each lesson is in accord with that which preceded it, and with that which is to follow it—each aiding each—

* Journal of the Royal United Service Institution. Vol. vi.

† National Military Systems of Bodily Exercise. By Archibald Maclaren.

each improving that which has gone before—each preparing the way for that which is to come; but this, of course, can only be done where provision is made for regular and consecutive instruction. Now regularity and consecutiveness, it will at once be seen, are quite incompatible with open air practice in any country whatever; and in a climate like ours are simply impossible. There are few days in the year that are really fit or suitable for such practice, or on which men would willingly encounter its discomforts; and a system of bodily training which is dependent upon the favour of the weather is in reality no system at all. My anticipations in this respect have been conclusively proved. In connection with the first gymnasium erected, that at Aldershot, which is comparatively small and inadequate to the requirements of so large a station, it was considered possible to extend the accommodation by the erection of certain machines in the open air, on a convenient spot in front of the building. For this purpose I prepared a plan of a gymnastic ground, embracing some of the most attractive and interesting articles of apparatus, on which exercises of competition and emulation might be performed. This was four years ago; but to this day a learner's hand has not been laid upon them; it is either too hot or too cold—too sunny—too windy—too wet or too something; but the fact stands out that, at a station where the gymnasium could give employment to but a small per centage of the troops, nothing whatever could be done with these open-air erections.

I have alluded to the discomforts of open-air practice; these may seem trifling, but when examined are more serious than appears at first sight.

To execute any gymnastic exercise, or any exercise indeed of any kind in which strength is to be exerted, or is to be derived from its performance, there must be complete freedom of clothing. This simply means that the soldier must be stripped to his shirt and trousers, with his neck open, his head bare, and his sleeves tucked up to his elbows. Now it is of the essence of gymnastic exercises, after the rudimentary lessons, that the efforts will for the most part be brief and energetic, with some necessary standing about,—waiting for and watching the efforts of others. And this with men so employed, and so exposed, and so constituted, is, save on rare occasions, neither sanitary, nor even safe in the open air.

I need scarcely, I am sure, state, that I, of all men, am least disposed to enervate or *coddle;* the whole work of my life has been, and is, and probably will be, to make men not only healthier but hardier; to teach them how to retain the strength they have, as well as how to add to its amount. But if experience has taught me anything, it has taught me this, that more evil may be done by rash and sudden exposure—by what is generally known as the *hardening system*, than by all the coddling in the world. It is not by exposure that men are either strengthened or rendered hardy; they must be strong and hardy, before they are fit to be exposed; they must be seasoned first, and exposed afterwards. If we cannot season a piece of timber by sudden, or extreme, or unregulated exposure, we must not think we

can do so with a living man, or a living anything; and from what I have myself seen, and from what I have learned from those who have had the most ample means of judging, soldiers are as sensible of discomfort, and as liable to injury from undue exposure, as any other class of men.

Another important reason why proper gymnasia are essential is, that they may be fitted up with apparatus of a character and description which could not be attempted out of doors. In elaborating my system of bodily training, I have found it necessary to invent many new machines to yield the special form of exercise which I desired in order to produce certain results in the learner; and almost all those which may be called of an educational character, and have for exclusive object to cultivate the resources of the body, require the roof and walls for support, and the soft floor of the building for safety; and those of an entirely opposite description, which have for special and direct object the teaching of the soldier to surmount obstacles, such as the scaling of walls, traversing beams and platforms, with and without implements and arms, can be erected, and the exercises practised on them, with much greater facility here than in the open air; for every portion of the interior face of the walls, and every part of the internal roof may be utilised for purposes of this kind, turned to immediate account, and made to serve as *bonâ fide* apparatus.

I say nothing of the facilities which a school presents over the open ground for giving and receiving instruction, and of preserving order and propriety among the learners, without having recourse to strict military discipline. For it is quite essential to safety, as well as to advancement, that the strictest order and propriety should be preserved in the gymnasium, at the same time that it is most desirable that formal military discipline should be relaxed during the lesson; and there is no fact more undoubted than this, that amongst gymnastic apparatus, the disposition of the learner to be inattentive and careless, and the difficulty of the instructor in communicating instruction and maintaining order, is uniformly beyond comparison greater in the open air than in the gymnastic school. Neither do I notice the safety arising from the assured condition of the apparatus in the gymnasium, exposed as it is to no atmospheric influence, always dry and always clean. Indeed while the out-of-door apparatus must necessarily be getting worse and worse, the indoor apparatus, if properly constructed, and its materials suitably selected, should be virtually indestructible. Nor do I dwell upon the advantages to the individual soldier, as well as to the service, which the building presents, of utilising bad weather—the very time when the soldier's frame most requires activity to sustain its power—the very time when his professional duties are necessarily suspended: and the equal, if not even greater advantage which it gives of utilising the long winter evenings, thus devoting to a source of health and strength, a leisure which is too liable to be spent in idleness and unworthy indulgence.

I have thus noted a few, and only a few, of the advantages which the gymnasium possesses over the gymnastic ground, but each one of these is most important in itself, and is pregnant with many others.

I would now inquire, are there any advantages on the opposite side, any advantages which the ground has over the building? And, if so, are they of such importance as in any way to counterbalance those which I have just enumerated? These are questions which I have fully considered, and I am prepared to answer, None—not one;—the open-air practice has not one real advantage; it has not even any apparent one which may not be shown to have a reverse influence and bearing.

Its apparent advantages are,—1st, ample space; 2nd, abundance of light; 3rd, pure air.

With the phrase "out of doors" and "open air," we are led to associate ample space, but this signification is often quite illusory when applied to the present subject; for it is found that the very places where gymnastic exercises are most wanted, where they would prove the greatest boon, are precisely those where ground is scarcely obtainable at any price or for any purpose, namely, in garrison towns and in barracks situated in closely populated districts. In such cases the advantage, of course, is all in favour of the building—in favour of the method which knows how to economise every square foot of ground, and to make it serviceable all day and every day, morning, noon, and night, wet or dry.

A small nook in a barrack yard, 80 feet by 40 feet, will be sufficient for a gymnasium, which will give abundant accommodation throughout the year to a garrison of a thousand men. They require no more ground than the apparatus covers; and they could use no more were it planted in the middle of the widest common in England.

The question of light, when examined, is solved at once; and I have no hesitation in saying that it is in favour of the building; abundant light for any purpose can be admitted into any building; and in the gymnasium it can be so admitted and so distributed, as to meet precisely the special wants of the special exercises.

The question of pure air is less easily disposed of, for there is nothing more essential to health and to health-giving exercise than pure air; while there is, on the other hand, nothing more liable to deterioration, for every breath we breathe acts injuriously upon it,—subtracts from it some portion of the good which it possesses, and imparts to it that which is pernicious; and it must be admitted that this process of deterioration is only sustained where the air is confined around the breather in a building, and is entirely avoided when he stands in the great air ocean out of doors.

Moreover it must never be forgotten that a gymnasium is a veritable temple to health in the highest sense of the word; and pure air, which is desirable everywhere, is imperatively necessary here, absolutely essential during exercise, not only for the perfect aëration of the blood, but as the natural stimulant to physical exertion.

And again, just in the same ratio with the requirement for the purity of the air in a gymnasium, is its liability to deterioration, first by the doubly increased respiration of the inmates—each breath being larger in volume, and each following each, in quicker succession during exercise than when the body is wholly or comparatively at rest; and

secondly, in a great degree also, by the exudations from the skin, which is stimulated to its utmost activity by the powerful and sustained muscular exertion; and it must be remembered also, that while these exudations are increased to their utmost extent by the energy and freedom of the partly denuded body, its escape into the surrounding atmosphere is also by the same means facilitated. Now while these are all incalculable advantages to the individual, and the very source and secret of the health and strength which he derives from exercise, they all tend directly and powerfully to deteriorate the air.

Another point still. Admitting that the gymnasium is occupied to the estimated extent of its working capacity, at the end of an hour (the usual time allotted to an ordinary lesson), the air in the building, were there not an unceasing interchange taking place between it and the external air, would be so deteriorated as to be rendered less suitable to the use, and less pleasant to the sense of the next batch of men, and less and less so with every succeeding one; for it is contemplated that every gymnasium shall be in full operation for many consecutive hours in each day.

Here, then, we encounter these important facts, not only that pure air is essential to health, and to the pleasurable sustentation of active bodily exertion; but that this exertion itself is a powerful agent in its deterioration, and that this deterioration is only felt where the same air has to be inspired and re-inspired, as in a building.

Now as this necessarily applies to all buildings, though not to all in an equal degree, we may be sure there is a way by which this evil can be avoided, for He who planned our existence did so with the full comprehension of our wants,—saw that while we were so constituted as to require the shelter and protection of dwellings, in which to live, and learn, and toil, that these very buildings expose to deterioration the substance on which we depend for momentary existence. The difficulty that seemed insurmountable is at once overcome by the action of the law regulating the constitution of the air itself. On the slightest change in the constituents of the air, such as that caused by respiration, or by the elevation of its temperature, it is impelled to instant motion—forced to shift and change its place, that place being immediately occupied by the surrounding air, so that motion and change of position is induced, proportionate in force and in extent to the primary displacement. This law is in unceasing and unerring operation over the whole surface of the globe, regulating equally the mighty currents caused by the sun's heat on the belt of the tropics, and the slight undulations in an ordinary room, caused by the breath of a solitary inmate. This law is the key to all our rational systems of ventilation. It teaches us to construct our dwellings in such a manner that the air, which is in unceasing motion—a mighty current ever flowing, though changing its direction with proverbial inconstancy—may pass through them in its course, cleansing them of every impurity. It teaches us so to regulate the admission of this current, that at any time, and at any season, it shall be in accordance always with the wants and the wishes of the inmates.

The special mode of ventilation for a gymnasium I conceive to

be—the building must be so constructed that the whole body of air within it may in a few minutes be changed for an equal body of fresh air, for this will be required at frequent intervals. It must be so constructed that the deteriorated air may ascend and pass at once out of the building, and a fresh supply at the same time enter; and these apertures for ingress and egress must be so placed, that the fresh air may be admitted at such distance from the inmates that it shall not strike them in compact cold currents, or draughts, as they are called, but be uniformly diffused; for this must be maintained throughout the working day. It must be so constructed, in fine, that it may be as snug as an ordinary room in winter, and as free and airy as the open heath in summer. And this should be done by what may be called *natural* means; that is to say, by simply bringing the internal and external air face to face, as it were, passing through no intermediate channel, forced together by no artificial means.

Thus much for the purity of the air; but air has other qualities besides purity, for we live in it as well as breathe it—it comes in contact with our skin as well as with our lungs; temperature, therefore, is very important. The air may be quite pure when the thermometer stands at 20 degrees below freezing point, as we have experienced this winter, or rises to 80 in the shade, as we felt last summer; but neither of these conditions are favourable to exercise, and least of all to gymnastic exercise.

Now, in a properly constructed gymnasium, the temperature of the air may be rendered pleasantly cool in summer, and sufficiently warm in winter to let men freely strip for active exercise. We do not want a heated or rarefied air to breathe during active exercise; men have the materials of heat within themselves, and want but exercise to ignite the fuel and sustain the fire; but we *do* want the temperature of the air so raised as to remove actual discomfort in stripping to work, and to dry and keep dry the apparatus, which must come in constant contact with the naked hand, and this can only be done in the properly organised gymnasium.*

Having thus, as I trust, shown the advantages of a properly constructed gymnasium, I will now notice a few of the principles which guided me in preparing a design for a building suitable to the system.

The first of these was, that the gymnasium should be of that form and manner of construction, as to admit of the erection of the desired system of apparatus, and to present the greatest facilities for instruction and supervision. The second, that it should be constructed to meet, in the best manner, the sanitary requirements which I have just noticed.

The third, that in all important respects, the same design should be capable of reduction or extension, so that its working capacity might be in proportion to the garrison where it was erected. In this last respect it was not necessary to compute the absolute working space

* For this purpose there is nothing so good as the open fire-grate, distributed in suitable places in the different divisions of the building.—A. M.

equired for every squad of learners, but to ascertain the smallest limensions of a building which would contain with adequate freedom a fair selection of the essential apparatus in the different sections of the system, and from this minimum size to ascend by carefully regulated gradations to a maximum size; the minimum to be adequate to the requirements of a station with half a battalion of men; the maximum to that of our larger stations, such as Chatham. I mention Chatham, because at that station I can perceive, not one only, but all the different classes of men, and each of these in large numbers, to whom the gymnasium must be the greatest possible boon. First, the recruit, in large numbers, this being the depôt of several regiments of different arms of the service; next the trained soldier in considerable numbers, this being a station where several regiments are quartered; and, in consequence, many young officers, for whom it is most desirable to provide suitable and attractive means of healthy and manly exercise.

Indeed, all the features of all other gymnasia should be combined in a gymnasium at a station of this extent and character, and the one recently erected there, and of which a model is before you on the table (see Plate XVIII), in my opinion does so. Nay, all departures from the plan of this gymnasium, should be but modifications of it, to meet some local or exceptional want.

The sanitary requirements of lighting and ventilation have been provided for on the most abundant scale, and as the official regulations on this point have been well considered and clearly defined, there is no room for failure with the most ordinary care on the part of those to whom this special duty is entrusted.

In preparing a system which aimed at providing means for the bodily training of the recruit and for the trained soldier, for the officer of matured frame, and for the yet growing cadet—a system which should yield not only adequate, but suitable and attractive exercise to all of these—it was necessary that it should be very extensive and wide-embracing; that it should be markedly progressive, and above all, that the early courses should be of such a character as to acomplish the setting up, the putting into proper position, and the correction of the evils in gait, action, and attitude of the recruit; that his whole body, and his whole body equally, should receive employment, and that the employment should be of the kind which would at the same time cultivate the contractility of the muscles, and the mobility of the joints; and also promote the expansion of the chest, and give that stimulus to the organs of respiration and circulation which is best calculated to increase their functional vigour.

For these important objects, and for the reasons explained in the book of the system,* I have discarded all exercises of mere movement and position, as affording inadequate action to the muscles, while giving extreme effort to the joints, as being equally severe or inadequate to weak and to strong, as admitting of no progressive advance-

* "A Military System of Gymnastic Exercises, for the use of Instructors." By Archibald Maclaren, Adjutant-General's Office. February, 1862.

ment, and as being inattractive and uninteresting, irksome, indeed, to all; and for my introductory course I have adopted a series of exercises with what I have called *moveable apparatus*, that is, with dumb-bells, single and double-handed. This lesson is so organised, that almost any number of learners may take part in it at a time, all acting by the same word of command.

The whole exercises of the system thus resolve themselves into two distinct kinds: first, those with moveable apparatus, and used for the first or introductory course, in which the learner lifts or wields the article of apparatus, he himself standing firm; and, secondly, those on the fixed apparatus, comprising the bulk of the system, where the learner himself moves or turns, the apparatus or machine being fixed or firm.

This distinction is very important, not only as affecting the character of the exercise to be performed, but the whole material means used in performing it, and actually necessitates a distinct division of the building itself into two parts, each part being in certain respects, in appearance and in fact, the very antithesis of the other. In the first division, that for the moveable apparatus, the floor is retained perfectly free and firm; the apparatus, when not in use, being ranged in racks along the walls. In the second division, the floor is made of soft and elastic material, with every spot of its surface mapped out and studded with apparatus permanently fixed.

For the first division there was needed simply a large room, but as I had long been impressed with the fact that at the depôts, to which our recruits are sent for the exclusive purpose of drill, there was no place where this drill could be carried on in inclement weather, and keeping in view always that the gymnasium should be the place for the instruction and practice of all professional bodily exercises, I so prepared this portion of my design, that at our depôts it might also serve, when desired, for the setting up and position drill of the recruit, and also as a school of arms, where fencing, sword exercise, and bayonet exercise might be taught and practised. One of these exercises which I have just named, fencing, is eminently suitable to officers, and yet it is one in which the officers of our army, generally speaking, are greatly deficient. I am convinced that they require but fair opportunities of instruction and practice to follow it earnestly and successfully, and I have therefore made special provision for the practice of this exercise, by a large fencing school, carefully planned and fitted up for this purpose, with suitable dressing-room accommodation.

I have already stated that in elaborating my system of bodily training, I have found it necessary to invent many new machines to yield the special form of exercise which I desired, in order to produce certain results in the learner; for instance, I have found that few men are equally developed on both sides of the body, as a natural result of the greater employment given to the right side during the period of growth, and this applies not only to the arm, but to the whole side, from shoulder to hip, and not unfrequently including also the lower limb, when the development of the right leg and foot preponderates over the left. Now I consider it of the greatest importance to health, as

it undoubtedly is to serviceability, that this lost balance of power should be restored, this equilibrium of development re-adjusted; and to accomplish this I have found it necessary to invent a number of machines, for the sake of the form of exercise which I desired to be performed on them. Among the first of these I would mention the elastic ladder and row of rings, machines designed expressly to give employment to both sides of the body equally, and especially to the chest and upper limbs, by necessitating that both sides of the body shall perform the same duty, requiring the exertion of the same degree of effort, and that neither side shall be able to aid the other; each side must do its own share of work, and can do its own share only; and therefore if the weaker side be doing as much as the stronger, it will virtually be doing more (being weaker), and the amount of difference in exertion will be of course in relation to the amount of difference in development or power. And therefore, the unerring result of the natural law of development being, *cæteris paribus*, in relation to activity, the weaker side will ultimately recover its lost position and its fitness for fair companionship with its fellow.

I have mentioned the nature and object of these two machines, for the two-fold purpose—1st, of showing that it was what I had discovered to be the actual wants of learners or pupils which guided me in preparing my exercises, and in inventing apparatus which would yield the form of exercise desired; and, 2nd, of showing that it was the form of that apparatus and the nature of the exercises to be performed on them which determined the form and construction of the building itself.

For instance, an important section of apparatus is that which teaches the soldier to clear objects by running, vaulting, and leaping; therefore for these considerable length is required. A second section of an elementary character, as the horizontal bar and the two machines which I have just described,—machines all capable of being worked by large numbers of men at the same time, and by the same word of command, also requires length; therefore the oblong shape, which admits of the apparatus of these important sections being arranged side by side, has been chosen for the gymnasium. A third section, consisting of all climbing apparatus, whether mast, rope, or pole, requires *height*: but as these are all vertically placed, they may be closely grouped, so that a small portion only of the building needs to be very lofty. These three sections of the apparatus in a very clear manner determine the most suitable and serviceable form of building, namely, an oblong, of a breadth about half the required length, and with one portion of it lofty. The position of this lofty portion naturally falls to the centre; for the two end walls are utilised for escalading, the one bearing every form of vertical apparatus; the other every form of slanting apparatus, connected by narrow platforms running along the tiebeams of the roof, in order to accustom men to traverse narrow objects at a considerable distance from the ground. I have utilised the elevated portion farther by making it serve in lighting and ventilating the gymnasium in the place where light is most wanted, and ventilation, of one kind, may be most effectively obtained.

The same form I found also to be the most suitable for the other division of the building, for the distribution of squads in the introductory course of gymnastics, for their arrangement during drill, and for classes of fencing and sword exercise. And as it was desirable for purposes of supervision and instruction that both divisions should form one building, and that every portion of it should be overlooked from every other portion, these two divisions have been placed rectangular to each other.

I have only now to notice the galleries for spectators. It is most desirable to encourage visitors to the gymnasium; it is wonderful, sometimes, how the presence of visitors serves to stimulate the learners to energetic action, and at the same time to assist in preserving the proper decorum of the lesson; but it is equally desirable that they should not mix among or in any way interfere with the learners. The galleries for spectators in both divisions are so arranged that they overlook the whole gymnasium without encroaching upon the working space.

I have already, on several occasions, laid before the public some of the results of this system of bodily training; first, when divested of its military bearing, in connection with the youths of Oxford, with whom the practice is necessarily voluntary, and liable to every form of interruption; and yet such is the want of systematised exercise with growing lads—such are the innate and latent resources of the human body, waiting but the opportunity of development, and such is the power of this system to draw forth these resources, that I have been able to establish beyond controversy the fact, that every youth who comes up to the University, whatever may have been his previous health and habits, has a large arrear of power still undeveloped, and of which a considerable instalment may be almost immediately obtained.

In a paper which I had the honour to read here two years ago, I was able to show that in a detachment of twelve non-commissioned officers, some of them of many years' service, the results of the system were as satisfactory as upon the young Oxford undergraduate. The men composing the detachment had been irregularly selected, the youngest being 19, the eldest 28, the average age 24; and after a period of eight months' training, the increase in the measurements of the men were—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
The smallest gain ..	5	1	$\frac{1}{4}$	1
The largest gain ..	16	5	$1\frac{1}{4}$	$1\frac{3}{4}$
The average gain ..	10	$2\frac{1}{8}$	$\frac{3}{4}$	$1\frac{3}{4}$

With a second detachment, in which the men were of more uniform powers, the youngest being 22, the eldest 26, and the average 24½, the increase in the measurements, after a similar period of instruction, were*—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
The smallest gain ..	1¼	2	¼	½
The largest gain ..	7	4¼	1¼	2
The average gain ..	2⅓	3	⅞	1¼

Within the last two years, the system has been so far extended into the army, that seven large gymnasia have been organized at important stations,† and are now in full operation, giving an ample bodily training to several thousand men; and I am enabled to state, that the returns of measurements on this wide scale confirm the results of the experiment made on small detachments.

It was wisely determined from the first adoption of the system by the Authorities, that the cadets at Woolwich and Sandhurst should have an early opportunity of sharing in its advantages, for whatever may be the value of a powerful and active frame to the soldier, it could be no less to the officer; and the advance in bodily power made by the cadets has fully equalled my anticipations.

I am indebted to Major Hammersley, the officer to whom the direction of the gymnastic training in the army has been entrusted, for a tabular statement of the measurements of a class of cadets at the Royal Military Academy at Woolwich, the youngest 16, the eldest 19, the average age being 17¾. In this class, in a course extending over four months, the increase was‡—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
The smallest gain ..	1	½	⅛	¼
The largest gain ..	8	5¼	½	1⅜
The average gain ..	1¾	2½	1/16	1

* Vide Appendix.

† The stations where gymnasia are already erected are, Aldershot, Woolwich, Warley, Parkhurst, St. John's Wood London, Chatham, Royal Military Academy, Woolwich, and Royal Military College, Sandhurst.—A. M.

‡ Vide Appendix.

Again, in another form still I have tested the results of the system, not by brief courses or periods of voluntary attendance, but by a year's steady practice from birthday to birthday, with two articled pupils, the younger being 16, the elder 20. In the year's work the increase was—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
With the younger ..	21	5	2	2
With the elder	8½	6	1¼	1½

I need not make any remark upon these figures. I can make none better than every gentleman who hears me now can make for himself. They simply record a complete transformation of the learner's frame; so complete, as to defy all comparison between it and that he possessed previous to the practice. And it must be remembered that this is not an acquisition to be retained only while following some exceptional course of life. It is what he can never wholly lose in this world again, because it is himself that is altered, it is himself that is changed—altered and changed only by being brought so much nearer to the power which he was designed to possess, and to the place which he was designed to occupy from his birth; a place from which he can never wholly fall, a power of which he can never be wholly dispossessed. Not even by illness can it be taken away; for, as his state was his legitimate state, and his power was a natural power, from illness he will rise again towards the height from which he fell.

In conclusion I would desire to draw your attention to this fact —a fact which all the tests of the system, and all the observations of my life go to establish, namely, that the advantages to be derived from physical training are all in favour of the *youth* of the learner. Get the man while he is young, get him, if possible, while he is growing; every year and every month of his growing time is worth double and quadruple the number of months or years after growth is completed; not only for giving shape and carriage, and activity, and muscular strength, but for giving that stamina of endurance to the whole frame, and that healthy and energetic action to the organs which, so to speak, carry on the whole work of life within the frame, which alone will make the man a man indeed, and enable him really to perform the duties of a soldier.

APPENDIX.

Tabular Statement of Measurements of the Second Detachment of Non-commissioned Officers selected to be qualified as Military Gymnastic Instructors,

FROM OCTOBER 27TH, 1862, TO JULY 12TH, 1863.

No.	NAME.	MEASUREMENTS, &c.							INCREASE.			
		Age.	Height.	Weight.	Chest.	Fore arm.	Upper arm.		Weight.	Chest.	Fore arm.	Upper arm.
		Years.	Ft. In.	Stone lbs.	Inches.	Inches.	Inches.		lbs.	Inches.	Inches.	Inches.
1	Corporal Mellor, 22nd Regiment, ..	22	5 10⅜	9 13	34	10	10⅝					
				10 6	38¼	11¼	12¾		7	4¼	1¼	2
2	„ Pike, 22nd Regiment	23	5 9⅜	12 0	36	10¾	12⅛		Less			
				11 11	39⅛	12	14		3	3½	1¼	1½
3	Sergeant Wilcox, Coldstream Guards ..	24	5 10⅜	11 2¼	36⅜	10⅜	12					
				11 4	39⅛	11⅛	13⅛		1¾	3½	1⅛	1½
4	„ Griffiths, Royal Artillery ..	25	5 9½	10 6	36½	11¼	12¼		Less			
				10 4	38½	11½	12¾		2	2	¼	½
5	„ Moss, Grenadier Guards ..	25	5 9⅝	9 12	34¼	10	11⅜					
				10 1	37⅜	10¾	12⅛		3	3½	¾	1¼
6	„ Adams, Scots Fusiliers	25	5 9¼	11 2¾	38	10¾	12					
				11 4	40⅛	11⅛	13		1¼	2½	⅞	1
7	„ Richards, Royal Artillery ..	25	5 11⅜	12 4	36⅛	11¼	12⅛		Less			
				11 9	39	12	13⅛		9	2½	¾	1
8	Corporal Pentecost, Royal Horse Artillery	25	5 9½	11 13	38	11¼	13					
				12 5	41⅛	11¾	14		6	3½	½	1
9	„ Pullin, Royal Artillery	25	5 8½	11 0	35	10¾	12¾		Less			
				10 11	38⅛	11⅜	13½		3	3½	⅜	¾
10	Sergeant Elliott, Grenadier Guards ..	28	5 10¼	12 3	38¼	10⅞	12					
				12 7	40½	12	14		4	2¼	1 1/16	2

Return of Course of Gymnastic Training at the Royal Military Academy, Woolwich,

FROM FEBRUARY 10TH, 1863, TO JUNE 22ND, 1863.

No.	MEASUREMENTS, &c.							INCREASE.				
	Age.	Height.		Weight.		Chest.	Fore arm.	Upper arm.	Height	Weight.	Chest.	Fore arm.	Upper arm.
	Yrs.	Ft.	In.	St.	lbs.	Inches.	Inches.	Inches.	Inches.	lbs.	Inches.	Inches.	Inches.
1	18	5	1 3/8	7	8	29 4/8	9 4/8	8 6/8					
		5	2 2/8	7	8	30	9 4/8	9 4/8	1	....	4/8	....	6/8
2	19	5	8 4/8	9	5 1/2	28	11	10 2/8					
		5	8 6/8	9	11	31 4/8	11	11 3/8	2/8	5 1/2	3 4/8	....	1 1/8
3	17	5	5 6/8	9	1	26 4/8		8 4/8					
		5	6 1/8	9	1	29 4/8	10 3/8	10	3/8	....	3	....	1 4/8
4	18	5	8 2/8	10	0	33	10 6/8	10 2/8					
		5	8 4/8	10	3	35	10 6/8	11 4/8	2/8	3	2	....	1 2/8
5	18	6	0 4/8	10	13	32	10 4/8	9 2/8					
		6	1 2/8	11	2	34	10 4/8	10 7/8	6/8	3	2	....	1 5/8
6	17	5	3 4/8	8	1	31	10 1/8	9 7/8					
		5	4 4/8	8	7	33	10 1/8	11	1	6	2	....	1 1/8
7	18	5	5 2/8	7	13	26	9 2/8	7 1/8					
		5	5 6/8	8	2	29	9 4/8	9 4/8	4/8	3	3	2/8	1 5/8
8	16	5	6 6/8	8	3	28 4/8	9	8 4/8					
		5	7 2/8	8	4	31	9 1/8	9 4/8	4/8	1	2 4/8	1/8	1
9	17	5	8 3/8	11	3	31	11 2/8	10 2/8					
		5	9 1/8	11	3	33	11 2/8	11 1/8	6/8	....	2	....	7/8
10	18	5	11 5/8	11	8	30	10 2/8	10 4/8					
		5	11 5/8	11	8	33	10 6/8	11	....	....	3	4/8	6/8
11	19	5	7 6/8	10	2	33	10 4/8	10 2/8					
		5	8 5/8	10	2	34 4/8	10 4/8	10 7/8	7/8	....	1 4/8	....	4/8
12	18	5	10 4/8	10	11	32	10 4/8	10					
		5	11 7/8	10	11	33 4/8	10 4/8	11	1 3/8	....	1 1/8	....	1
13	19	5	7 7/8	11	13	33	11 4/8	12					
		5	9 3/8	11	13	35 4/8	11 4/8	12 4/8	1 6/8	....	2 4/8	....	1/8
14	17	5	6 6/8	9	13	29	10 5/8	8 2/8					
		5	7 5/8	10	3	32	10 5/8	9 4/8	7/8	4	3	....	1 1/8
15	19	5	10 4/8	10	1	27 4/8	10 5/8	9 3/8					
		5	11 7/8	10	9	32 6/8	10 5/8	10 7/8	1 3/8	8	5 3/8	....	1 3/8
16	18	5	3 2/8	8	13	29	10 1/8	10 4/8					
		5	3 4/8	8	13	32	10 1/8	10 2/8	2/8	....	3	....	2/8
17	18	5	8 6/8	11	8	33	11 1/8	12 7/8					
		5	9 3/8	11	8	34 4/8	11 1/8	12 7/8	7/8	....	1 4/8	....	....
18	17	5	6 1/8	9	8	27		8 6/8					
		5	7 1/8	9	8	30 4/8	10 3/8	10	1	....	3 4/8	....	1 2/8
19	16	5	6 4/8	8	10	27 6/8	9 4/8	7 4/8					
		5	6 7/8	9	1	30 4/8	9 7/8	9 4/8	2/8	5	2 6/8	2/8	2
20	18	5	7	9	1	28 2/8	10	9 4/8					
		5	7 3/8	9	1	31	10	10 4/8	3/8	....	2 6/8	....	1
21	18	6	1 1/8	11	12	34 6/8		11 7/8					
		6	2	11	12	35 1/8	11	12 1/8	7/8	....	1 1/8	....	2/8

APPENDIX.

PROCEEDINGS AT A SPECIAL GENERAL MEETING.

A Special General Meeting of the Members of the Royal United Service Institution, was held in the Theatre of the Institution, on Monday, May 2nd, 1864, at 4 p.m., to consider the propriety of altering the Bye-Laws, section II, par. 1, so as to entitle the Officers of the Royal Naval Reserve to become Members without ballot.

Colonel P. J. YORKE, F.R.S., Vice-President, in the Chair.

The CHAIRMAN: This meeting is called agreeably to a notice which has been given, which the Secretary will read, and which will explain the object of it.

I. The SECRETARY read the notice convening the meeting.

The CHAIRMAN: I may mention that the Royal Naval Reserve is a corps that has been instituted since the printing of our rules. The object of this meeting is a very simple one. It is merely to entitle the officers belonging to that body to become members of this Institution, on the same footing as Officers of the Navy, Army, Militia, and so forth. The Council found, that according to the rules, they could not admit these gentlemen on their own authority, and they have been, therefore, obliged to call a General Meeting; a very simple measure will carry out the object in view; and there is a simple resolution prepared, which I will ask Sir Frederick Nicolson to move.

II. Rear-Admiral Sir FREDERICK NICOLSON, Bart., C.B.: I have much pleasure in moving the resolution which has been put into my hands; and it is hardly necessary for me to detain you above a minute, in stating anything with respect to the Royal Naval Reserve. It has long been known by every person who has taken an interest in the Navy, that the great difficulty we had to contend with was in manning ships after they were ready for sea, and likewise in manning ships when, in the event of a great war, it was absolutely necessary to send them to sea without any delay whatever. In order to meet these difficulties, the Royal Naval Reserve was instituted, as drawing men, I may say, from the great reservoir of the seamen of the country, and likewise as being a means of connecting the two services together—connecting the Royal Navy with the Mercantile Marine. I am sure that I and my brother Officers will be most happy to see the Officers of the Royal Naval Reserve members of this Institution; and I have very little doubt that the other members of the Institution, not be-

The Journal

OF THE

Royal United Service Institution.

VOL. VIII. 1864. No. XXXII.

Evening Meeting.

Monday, April 18, 1864.

LIEUTENANT-COLONEL T. ST. LEGER ALCOCK, in the Chair.

NAMES of MEMBERS who joined the Institution between the 4th and 18th April, 1864.

ANNUAL.

Douglas, Sir Robert, Bart., Capt., 57th Regt. 1*l.*
Holmes, H. R., Lieut., R.N. 1*l.*
Baldwin, G.W., Major, 20th Regt. 1*l.*
Scott, J. D., Colonel late Mad. Art. 1*l.*
Law, Robert, K. H., Major-General, Col. 2nd W. I. Regt. 1*l.*
Errington, A. J. Lieut., R.N. 1*l.*
Clayton, V. G., Lieut., Roy. Engrs. 1*l.*
Saumarez, Hon. James, Lieut., Grenadier Guards. 1*l.*

THE CONSTRUCTIVE SERVICE OF THE ARMY, OR MILITARY WORK BY MILITARY MEANS.

By Lieutenant-Colonel MILLINGTON H. SYNGE, R.E.

The CHAIRMAN: As the lecture which we are about to hear from Colonel Synge is likely to be followed by a discussion, I will take this opportunity of stating that as these discussions are of considerable importance, and interesting to members in every branch of the service, we are very anxious that our reports should be accurate. When gentlemen are kind enough to address the meeting, we can easily afford them the opportunity to correct the proofs; but we must pro-

vide against those corrections which amount to what is usually called a "*revise*," because a "*revise*" greatly increases the labour as well as the expense of publication. It likewise retards the appearance of the Journal, which is, to our absent members, a matter of regret. The subjects discussed at these meetings are usually those of the day, and absent members are anxious to hear the opinions of distinguished and experienced officers upon them. It is, therefore, a matter of much importance that our Journal should be issued at the proper time. Gentlemen are aware that we spare no trouble to conform to their wishes, but we are obliged to lay down this rule in consequence of the increased amount of labour occasioned by prolonged discussions, such as I hope we may be favoured with on the present occasion. I will now call upon Colonel Synge to commence his paper.

Colonel SYNGE: I. An army, to be perfectly equipped, ought to include *within its own constituent elements* a full provision for the supply of all its wants, and for the performance of all its duties.

The efficiency of an army is necessarily always in proportion to the completeness with which this provision is made and carried out.

The organisation *for* an army *must* make such provision, or failure at some stage is the inevitable result; but an army is incompletely and imperfectly equipped, if it does not include that provision *within its own organisation.*

II. Moreover, every arrangement made in connection with an army should be viewed in its relation to the primary object and paramount end of all armies, which is, fighting power.

III. Again, the arrangements should be confined, as strictly as is possible, to that which is essential. Whatever contributes to the essence of the army, in other words, whatever contributes to its fighting power, and is essential, should be provided, and nothing that does not.

Any provision made, or any arrangement introduced, that fails in this respect is necessarily injurious to the extent that it is made or introduced, but everything that does so contribute should be provided fully, and should be made available by an instrumentality as simple and as direct as possible.

IV. Every complex arrangement is in itself to be avoided, and bespeaks its own condemnation in its complexity.

Needless complication cannot be too strongly condemned.

Fighting power, the essence and object of armies, is determined by number and quality. These, therefore, should be the objects constantly in view, and no arrangement that fails both in increasing the number and in improving the efficiency of the army ought to be admitted.

The works required for the maintenance and by the duties of the army furnish preeminently an occasion when these maxims ought to be regarded in practice. The expenditure must, in any wise, be incurred, for the works must be supplied. If this be done by an instrumentality available as a combatant force, the same expenditure by which the works are supplied will besides both increase the numerical strength

and add to the efficiency of the army. Such would be, in every respect, the most economical means.

The whole strength of the army is not required to exceed that by which the duties for which it is wanted can be performed, and its own necessities supplied.

The constructive requirements are in like manner limited to those connected with the duties, or consequent upon the existence of the military force. It is clear, therefore, that the aggregate expenditure for military purposes is brought within the smallest possible compass, as well as most efficiently applied, when the same expenditure which supplies the constructive requirements, furnishes, also, in the act of doing so, a portion of the military force.

This may be briefly summed up in terms that carry conviction with them,

MILITARY WORK SHOULD BE DONE BY MILITARY MEANS. Plainly, if the work that is now done by a body of men who are not available for military service were done by a like number that would be so available, the numerical strength of the combatant force would be increased to that extent.

So, also, to increase the efficiency of the units of which the aggregate of the army consists, is to increase the efficiency of that army as a whole; and to call into exercise the intelligence, resource, and physical energies of those units, is to increase their individual efficiency.

If officers and soldiers can plan the works and buildings required by their duties; if they can superintend the carrying them out; if they can execute those works, it may assuredly be affirmed, besides, that no other instrumentality can be so well cognisant of the true and actual nature of all military requirements; neither, in all probability, could those requirements be met at once so readily or so completely by any other instrumentality.

The combination of the structural and combatant functions is, if it be practicable, the perfect attainment of the end in view.

The chief practical aspects of *this* question are:—

First, from the military point of view, the effect upon the soldier of employment on military works.

Secondly, from the constructive point of view, the value of military labour in getting work done.

The soldier is affected (*a*) personally,
(*b*) in discipline, and
(*c*) in pay.

Can his employment on military works be combined with the necessary exercise and discipline of his calling and with economy? Will the receipt of greater earnings militate against his subordination and discipline? What will he do with the wages of his work?

The partial employment of military labour in the design, the superintendence and the execution of works, is an established custom. It takes place, to a greater or less extent, probably in every Service known, and the men so employed are conspicuous rather for higher than for inferior military bearing, proficiency, and character.

It is a question, therefore, of enlarged detail and practice, more

than of novelty of principle,—of the feasibility and probable results of extending the sphere of operations of a system, the effects of which can, in a great measure, either be stated from actual experience and fact, or accurately inferred from close analogy. It is not the suggestion of anything untried.

First, then, as to the soldier's individual efficiency and value.

Variety of occupation and active bodily employment bring into use all the different muscles of the frame, and thereby conduce not only to bodily health but to suppleness and usefulness, changing and correcting the somewhat stiffening tendencies on both mind and body of the habits into which the less intelligent and active men are but too apt to fall. Thus the sanitary condition of the cavalry is, as a rule, superior to that of the infantry, and this often, notwithstanding less favourable surroundings. The Royal Engineers have a less proportion of sickness among their numbers than the ordinary regiments of foot. The difference is so decided that it affects the mortality as well as the effective states of the several bodies. In other words, handling the currycomb and brush, or the use of the spade and pickaxe, and the employments of artificers and labourers, are beneficial to the health and longevity of the soldier. This is a matter of no little importance, when it is considered that a soldier of the line is estimated to have cost £60 before or by the time his training is complete.

Intelligence, which cannot fail to be developed by practical training in even the ruder kinds of skilled labour, more especially when the whole course of that training is directed towards supplying particular and personal requirements, is of great military value. The highest authority has affirmed that it is more effective than a great amount of drill towards perfecting the soldier as a marksman, in enabling him to chose and to adapt his position so as to place, use, and point his weapon to the best effect. It has been similarly determined that intelligence, activity, and the habit of exercising faculties of resource certainly best attain the important objects of light infantry movements, of which the execution depends upon the qualifications of each individual in these very particulars.

[Will you allow me to interrupt the lecture by a subject that probably may not arise in the discussion. When my paper was drawn up some years ago, it was based upon the experience in this respect of the previous Hythe practice. When that practice was first set down and tabulated, the Royal Engineers took a very high average. We have since very much fallen off, to the surprise of many of my brother officers; but I believe a simple explanation that has been suggested to me will meet the case, and I mention it here because I am not aware that it has ever been brought forward publicly before. Musketry instructors state that men of intelligence make the best marksmen; and the higher intelligence of the Royal Engineers probably made them better marksmen than the men of other regiments in the first instance. But other regiments are constantly practised in this one particular, and this constant practice would be altogether wasted, and fail in its object, if it did not at last give these regiments a higher relative position, putting out of consideration the fact that

the Royal Engineers are supplied with an arm of which the ammunition has now a different* windage. Quickness, intelligence, and education will tell; but when so much attention is devoted to one particular object, that is education in that matter, and it would be a melancholy reflection if no corresponding result were attained. If so, it might be argued, the less musketry drill we had, the better, which were going too far altogether, and I think the suggestion offered explains in a great measure the falling off of the Royal Engineers in their comparative standard and their figure of merit that has been noticed.]

In all these respects the soldier's efficiency and consequent value will have been increased; and so far as his abilities and general aptitude have been improved, he will have become more rather than less amenable to discipline. Neither will the *habits* of discipline deteriorate under a thorough and complete military organisation and system of carrying out the works. The maintenance of drill can be perfectly provided for by an adequate allotment of time specially determined.

In fact, the discipline of the soldier is only liable to be injuriously affected, if so liable at all, through the effect upon him of the receipt of wages for work done.

The classes of the army that under a military system of executing works would be in receipt of this increase would be, first, a proportion of those men by whom the works are executed at present as civilians, or others, of like standing and similar qualifications; and, secondly, a proportion of the existing army. With the attractions of permanent and fixed employment, and of the opportunity of rising to masterships of their own trades, to grades of overseerships, to duties of superintendence or of design, no doubt a considerable number of the former would enlist, if only the detail of the code of regulations be judiciously and equitably devised; so that the position of a man, in other respects yielding precisely the same service as civilians now do, should not be deteriorated in his very employment, as is now frequently the case, merely because he also served his country as a soldier. Of this body the artificers at least are superior to the general class of men who now enlist, and in so far, the addition to the army would not be of numerical strength alone, but markedly of efficiency and value. In fact, were it determined to procure the enlistment of a better class of men than is obtained at present, the means employed would be an increase of bounty and of pay, and a well-grounded expectation of improving prospects. It may therefore be fairly assumed that on the establishment of these conditions, their favourable influence would be felt by the army generally, although they had not been adopted primarily with that object, but were simply incident to the extension of a military system for the provision of works.

With regard, secondly, to the proportion of the existing army that would be directly affected, it must be conceded that, inasmuch as the invariable demand of all agencies that seek to promote the amelioration of any class of society is for money, the presence of money in the question is at the least not necessarily unfavourable to its satisfactory

* I believe it has been recently decided that the windage is a chief cause.—M.H.S.

solution. The matter really to be considered is, how the soldier can be induced to make a good use of his earnings in a manner consistent at once with his absolute property in the same, and also with his discipline and with his position as a soldier.

If opportunities can be set before him for the investment of his earnings in a manner alike beneficial to himself and to the state, and if inducements strong enough to cause him voluntarily to act upon them can also be brought to bear upon him, the object will be attained.

It is not difficult to point out an opportunity and an inducement of sufficient force. These can be afforded the more easily, since the numbers employed upon works would always be but a certain proportion of the whole army. The privilege of being so employed could therefore always be withheld from such men as were found to make a bad use of their earnings, or to be unwilling to adopt the approved arrangements.

Giving the soldier of a certain standing greater liberty of marriage, throwing upon himself all the consequent expenses, would afford both the opportunity and the inducement. There are grounds sufficient for inferring that such liberty would act as favourably upon the general health, strength, and morality of the ranks as it would be effective in reducing the unproductive expenses of that portion of the service. The additional requirements of a married soldier form, in fact, the barrier that restricts the permission to marry to a very small proportion. These additional requirements are, increased accommodation in barracks or quarters, more medical attendance and additional transport. These, as is obvious, can all be met without great difficulty, *in the presence of adequate funds*, merely requiring judicious regulation. The execution of works would supply those funds; and meeting these wants would be their best investment by the soldier.

No doubt there are many officers, and amongst them officers of much experience and of well-earned reputation, who look upon the possession of money by the soldier as his greatest temptation and misfortune, and who would be disposed to look with little favour upon propositions for giving greater liberty to marry. They hold that as a rule the soldier is the scamp of the town or the refuse of the village, with tastes bounded, at the best, by the canteen. There are officers on whom their own experience has worked a strong conviction, that a brave and useful soldier may yet be in all other respects a thorough blackguard. Indeed, it is not very long ago since a proverb was rife closely connecting infamy of disposition with value as a soldier. If this be the right view, nothing can be said. All projects of amelioration are alike hopeless. Far from being brought forward, the soldier ought to be removed from every place of trust, even in his own profession, wherever it can be done. A class that could be viewed only as an inevitable evil, which in times of peace and prosperity has been called so bitterly and so contemptuously a shilling's worth of food for powder, ought to be limited to the smallest number possible; but if this be the correct view, there are quite another set of votes to be dealt with. The educational and sanitary projects, the whole esta-

blishments of chaplains, and the vast machinery and outlay which have been the work of recent years for the improvement of the soldier, ought in all consistency to be abandoned without farther loss.

There is, however, quite a different and a better light in which to take these votes. They show that a better and a sounder opinion prevails even now, of the real characteristics of soldiers, a truer standard of what they ought, and may be helped, to be. These votes are the result, moreover, of the increased interest in and attention to military matters which the events of recent times have forced upon the country. Nor are these very opposite opinions so irreconcileable as at first sight they may appear. Ordinarily a man is very much what circumstances and inducements make him. Granted that a casual sum of money may prove the occasion of the greatest misconduct of a soldier with no other inducement to its outlay than the canteen can offer,—granted that some commanding officers may conceive themselves borne out by every instance within their particular experience of the bad effects upon the conduct and discipline of their own regiments, of sums earned on occasions of working parties having been furnished, yet it would by no means follow that any like result should attend the systematized and constant employment of military labour upon military works.

Quite the reverse. Else the Royal Engineers, the Commissariat Corps and the like, would be the worst and not the best conducted and most trustworthy components of the army; and similarly, the Guards and cavalry, with higher rates of daily pay, would be inferior to the line.

The soldier will do with the wages of his work very much like any other man, what he may have the opportunity of doing; what he may be judiciously induced to do. If hitherto he has spent his chance earnings at canteens, has it not been very much the consequence of circumstances? In part, because they were *chance* earnings; in part, because the temptations of the canteens were at hand, not so any definite want or inducement to exert upon him the force of a less unfavourable influence.

The foundation of the manliness of the English character, the essence of its greatness and its strength are, perhaps, speaking of qualities alone, its self-reliance and its independence. The feature that peculiarly marks our military administration has been to do everything, and, as it were, to think every thought for the soldier. He is brought not only to habits of absolute obedience and of perfect discipline within the duties of his calling, but beyond the range of these he has been practically very much reduced to the conditions of helplessness and childishness.

His marrying has, as a rule, been necessarily inhibited. His chaplain, his school, his library, his reading-room, his ball courts and his canteen, all are provided for him. It is only at the last that he is called upon to spend his own money, and to bring his own faculties into exercise before he can make use of the establishment.

I do not wish to be misunderstood. Since this paper was drawn up, there have been many modifications. Soldiers now subscribe to

reading-rooms, and to other similar improvements. Still the canteen remains a prominent attraction; but the observation hardly now holds true, that it is *there only* a man must exercise his faculties and choice.

Yet, notwithstanding the general inhibitions of marriage, the proportion that are allowed to marry, and the proportion that marry without leave, form, with the consequent number of children, one of the most difficult elements of the army to deal with satisfactorily. Small and insufficient as that proportion relatively is, it crowds a barrack, or else renders its construction enormous. It is in the way in the allotment of camp accommodation; it is *the* difficulty on board ship. On the march, or on embarkation, many women and children are necessarily left behind; many families become destitute and fall a burden upon the Government or upon the parish. Yet the large *un*married proportion of the army does not generally yield the oldest, the best, the steadiest, or the most trustworthy and available soldiers; but it *does* furnish the principal ingredient of the hospital and of the military prison. An ingredient so large, so important, so damaging and so costly, that it has been found that a proportion as great as one twenty-fifth of the whole army is permanently supported either in the hospital or in the prison, unavailable for service and heavily encumbering the estimates, utterly unprofitably.

The employment of military labour on military works opens a solution to these difficulties. It affords the opportunity of throwing the expenses incidental to marriage, upon the man himself, as is the case in every other condition of life: The service is freed from the responsibility and the Government from the burden, of providing them, whilst the soldier himself is put in a position to earn and to provide them. In fact, the pressure that is now experienced has been caused in a great degree by the soldier having had no opportunity of making any such provision, whilst continuing his military service. It has resulted from an artificial practice, that has shut him out from a field of legitimate employment, and which has inevitably carried with it other restrictions, artificial consequences, forced necessities, and mischievous habits. When this practical prohibition is discontinued, and military labour resorted to within its proper sphere, these evils will also cease. The soldier will be placed, in respect of his domestic life, upon his own industrial resources. He will be enabled to supply and satisfy his own wants. No means has hitherto been practised; he has either been refused the habits of natural life, or he has been supplied at the cost of the country with the necessaries consequent thereupon. He has either been forbidden to marry, and condemned to an unnatural celibacy, or his wife and children have been housed, fed, schooled and physicked at the cost of the country. These extremes and this anomaly may be ended, the moment the soldier himself is placed in a position to meet the expenses of providing for these wants. The experiment of throwing the soldier more upon the result of his own exertions has succeeded to the extent that it has been tried; the employment of military labour seems admirably adapted to its wide extension. In particular cases soldiers married with leave have been accommodated with quarters under light payments. The supply

of rations at fixed charges is on the same principle. Similarly if quarters in or adjoining to barracks and camps (with a garden ground where practicable) were let to married soldiers at rents, light but still remunerative, and if by an arrangement similar in principle, the transport of his wife and family to his station for garrison duty were provided (not necessarily in the same vessel as himself), or that family allowed at his option to remain in the abode they rented at the time of his departure, or in one similar, the service would be freed from the greatest impediment and hindrance to the quick, easy and compact movement of troops. The free percentages already conceded, could still, if it were desired, be provided in the quarters or in the ships, under fixed charges for the others. Such an arrangement might be made with advantage both to the country and the service even as it is, for it is the helplessness of the soldier and his ignorance of civil life, which, together with the avaricious and passion-pandering characteristics of those who generally inhabit garrison towns to make their prey of him, that complete the position in which he falls under the influence of the canteen or drinking shop, exercising no thought beyond the moment, and without help in the hour of need.

In like manner with regard to the younger and unmarried soldier, a more extended system of recreative amusement,* both in the way of bodily exercise and of mental cultivation, would afford a wide scope for a beneficial expenditure of his working pay. For example, *his own* ball-courts, cricket, and game grounds of all kinds, with refreshments, all under judicious regulations, but in measure or wholly originating in his own resources, and under his own management—the more thoroughly under his own care and management the better; his reading-room and library, his club, in fact, similarly governed, would doubtless be found full of fresh attraction.

A fund, to which contribution should be compulsory on all allowed to avail themselves of the privilege of going on the works, would meet the cases wherein the misconduct of individuals, after being allowed these indulgencies, would have otherwise involved the country in expense. A proportion of their countributions to this fund, greater or less, according to circumstances, might be repaid to men on their discharge after a term of unbroken good service, which would probably cause the fund to be approved by all, excepting such as might forfeit their share on transfers, or by any other expenditures, incurred through their own misconduct. To others, it would prove, in fact, somewhat analogous to a savings bank, and it would be the common interest of all to prevent this diminution of the fund through misconduct. Thus, both in the case of the married and the unmarried man, the execution of military work by military means, far from exercising a deteriorating influence on the discipline or habits of the soldier, through the wages received for work done, affords the means of solving, without involving the country in any additional expense, one of the most difficult problems in the management of the army, as well as the opportunity for carrying out military life in accord-

* Recreation rooms are carried out upon this plan with the best results.—M.H.S.

ance with the laws of nature; yet it would at the same time both greatly reduce the non-effective expenses of the army, and facilitate its accommodation in barracks, as well as its movements on ordinary service, nay, even on active service, in so far as it would leave the soldier's family better provided for when he himself was called away from beside them.

Next, as to the value of military labour in getting work done. Under this aspect, the question is simply a consideration of relative cost and of sufficient workmanship. In viewing it, however, from this exclusively constructive and civil point of view, it is very necessary to bear in mind that the result arrived at must be modified by the value to be attached to skilled labour, as an essential and indispensable ingredient of an army before the inquiry has been practically dealt with in its completeness and truth.

Moreover, in instituting the comparison itself between the cost and quality of civil and of military labour, it has to be remembered that the regulations which now affect the latter are, as it were, incidents merely in the code of military rule, and that they have not been framed with the primary object of using the labour of the soldier to the best advantage.

A comparison, however, has been instituted under these conditions, which are necessarily less favourable to military labour than would be the case were it generally employed, and adequately organised for that end. Sir J. Fox Burgoyne has published, in his "Military Opinions," the very careful analysis given in full detail by Quartermaster Conolly, of the Royal Engineers, who has written the history of the late Royal Sappers and Miners. It appears from this analysis that the entire cost per man on a company of Royal Engineers, does not exceed 3s. 4d. a day each, when every expense has been included of bounty, drill, instruction, barracks and hospital accommodation, provisions, working pay, clothing, and pensions. Quartermaster Conolly shows a saving of £614 15s. annually on the employment of a company of Royal Engineers, instead of a corresponding number of civil artificers, of the trades which constitute by regulation a company of Royal Engineers.

[Since I have taken this from the sources quoted, I have seen compilations made by brother officers on entirely different data, thrown together differently, yet resulting exactly in the same amounts. This is corroboration, although it may be said, that corroboration on a subject like this that Sir John Burgoyne has adopted and given his countenance to, is like "painting the lily, and gilding refined gold."]

Upon this, General Sir John Burgoyne observes:—"As the work "must be performed, and as the engineer soldiers are intended to be "habitually employed in work, it is evident that the difference of cost "of what is performed by them from what it would be by ordinary "means, will mark the *bonâ fide* expense to the country of their "maintenance."

Since the work must in any wise be done, the result is practically that the country obtains the war services of as many men as are employed upon works in time of peace, not only virtually free of cost,

but at a positive saving, which on the aggregate of works would amount to a very considerable sum. These men are besides of higher average individual intelligence than those who usually enlist; they become trained soldiers, they are taught the duties connected with the operations of an army in the field, and more particularly at a siege; but notwithstanding these admitted facts, military works are principally carried out by civil instrumentality throughout, whilst the number of these combatant men maintained is only 40 companies, or 3,818 men, (exclusive of two troops, or 4,294 in all) or about one-fifth that of the Royal Artillery, two-thirds that of the Foot Guards, and is very nearly equalled by the rifle brigade alone.

According to the authority above quoted—and none could carry greater weight for accuracy and experience in this matter—the saving in executing military works by the Royal Engineer soldiers instead of by corresponding civil artificers, would be, by the analysis afforded, about 8 per cent. It has indeed also been said that this comparision is instituted with a class of artificers somewhat superior to the average of Royal Engineers; but against this must be set the fact that in the extensive adoption of military labour a large proportion of that required, could be and ought to be furnished by a class less costly than the artificers of the Royal Engineers. There is in every regiment a number, greater or less, of men, who although not absolutely capable of executing artificers' work independently, are quite able to work under trained artificers, of acquiring a good degree of handiness, and of becoming at the least more full of resource than they are on their enlistment. They are well fitted for helping in rougher kinds of work, and for acquiring an aptitude invaluable in the emergencies of actual service. To men of this description, who are of a class especially calculated to make good soldiers, the prospect of employment on military works would be as attractive as it would prove beneficial to the service, so that whilst the combatant force would be added to in one of its most valuable elements, the work suited for execution by such means would be performed by the instrumentality most appropriate, and in part less expensive than that on which the above comparison has been based.

Contract, however, and not the direct employment of civil artificers, is the system almost invariably pursued. This circumstance introduces another element of uncertainty in estimating the positive relative cost, but it is probable that the expenses involved in the contract system are in some cases in excess, and in others below those on which the above estimate of civil artificers has been based.

Be this as it may, and the *amount* of saving that would ensue proportionably difficult to determine, it can but too easily be shown that the merits of the question do not rest upon absolute accuracy in this particular. The army estimates for this year, 1864–5, amount to £14,844,888, of which the charge for the effective services of all kinds, exclusive of militia and volunteers, is £11,579,802. That for works and buildings is £750,870, and any instrumentality which would reduce so large an expenditure, were it only by a very slight proportion, is as deserving of consideration for its financial bearing on the

aggregate army estimates, as that proposed has been shown to be to military economy, and to the soldier's general efficiency and well-being. This is clear, for assuming that of the £750,870 for works and buildings, one-half only represents payment for labour, and that the rest is for materials, in which there would be no change of cost, the employment of military labour would yield, *first, a combatant force equal in numerical strength to the number of civil artificers and labourers employed throughout the year*, and of the qualifications of the Royal Engineers; *and, secondly, a saving* varying respectively at ten, five, or one per cent., from £5,000 to 25,000, and £50,000. At fifteen per cent. the saving would be £75,000 a-year.

As has been already said, however, the true value of military labour in the execution of military works must not be tested from a financial point of view exclusively, be the result ever so satisfactory, or rather if it be so tested, it must be on a full view of the whole case. The indispensable necessity of skilled labour in modern warfare must have the weight and prominence which are its due. The extent and quality of skill that, if not altogether indispensable, it is yet of the utmost advantage to have at command, must also be considered. If the question is to be determined as a matter of finance, the monetary value of such skill and practice in the emergency of war, and that of the best school for procuring and for maintaining it must be added to the score.

The Design and Superintendence of the works required would supply and cultivate the higher portions of this skilled labour. Upon the mode of carrying these out must depend in a great measure not only the success, or otherwise, of the military execution of works, but also whether or not a large body of officers, non-commissioned officers, and men, is to be maintained, trained, and employed to the greatest advantage, and available at any moment, with matured experience, for active and immediate service in the field.

Superintendence must necessarily be carried on either by military, civil, or by mixed means. A wholly civil instrumentality need scarcely be discussed.

The requirements and constitution of an army necessitate, at the least, a military admixture. Military men must, or certainly ought to be, better acquainted than others, both with the wants of the service and with the best ways of meeting them. Officers conversant with the operations of a siege, and with many other matters of field service, are indispensable. These must clearly be trained in time of peace, and their general services ought also to be then available. To supply this indispensable need, and to provide this training, the corps of Royal Engineers has been formed and organised, and placed in charge of all fortifications, with the buildings and lands attached, and of the superintendence of the execution of all works and buildings.

Owing to the great preponderance of the execution of works by civil means, the officers of this corps are in point of numbers proportionably in excess of the corps of artificers whom they now officer under a common name; but the non-commissioned officers of this body ought to be similarly qualified to conduct the subordinate duties in the super-

intendence, and their employment in this manner, a practice already in partial operation, might readily be organised so as to be attended with great advantages.

If these together be in sufficient number, there is evidently no need of the addition of a civil admixture, and the latter can only be introduced to supplement some deficiency, real or supposed, in number or in qualification.—[See Appendix A.]

The substitution of a military system is rendered comparatively easy, inasmuch as the present system has in all respects a partially military organisation; and a gradual increase of the military features would effect the transition to its complete adoption in the best manner. Thus carried out, no injury whatever would be inflicted on so much as the prospective interests of any of the civil assistants on permanent employment; and no additional expense would be incurred even at the first beginning of its more extended application; no difficulty, shock, or inconvenience would be felt in the working of an existing system, as there would be no sudden substitution of either one class of persons or of duties for another. The transition might be begun by replacing the civil temporary appointments, of which 87 appear in the estimates, by as many military substitutes as might be found at once available and competent for the purpose. The employment and promotion of the permanent civil assistants being carried on with no other change than the cessation of new civil appointments at the bottom of the lists, their interests would be left entirely untouched, and their services would be available as now; only they ought to be placed exclusively as assistants to senior officers, where they would be *assistants*. And they should be employed in training to the duties of superintendence, and to the minutiæ of plans and estimates, the best tradesmen amongst the non-commissioned officers and men, precisely as they now do their civil juniors. They have themselves been trained in this manner, and have thereby become gradually familiar with the general duties of the service after their own special apprenticeships in their previous civil life.

In order fully to obtain the advantages that are to be derived from the employment of military labour in the execution of works, both in respect to the labour and the men themselves, a brief code of regulations is required, framed with especial reference to these points, and to the co-operation, or the reconciliation, so to speak, between military duties and the employment of labour to the best advantage. The former of these objects, that is, the due performance of military duties, has frequently been quoted as an insuperable obstacle to the perfect attainment of the latter. All, however, that would be necessary in order completely to secure it, would be, to determine first the amount of military duty necessary to be performed, and then to carry it out subordinately in point of *time*, to the particular work or job on which the man, squad, company, detachment, or regiment might be employed; the *amount* being absolute and paramount, but the *time* or roster varied under the orders of the officer commanding, according to the work actually in hand. Although carried on at special times and in special localities, the course of musketry instruction now in force

does not militate against any other of the soldier's duties. The principle of the two cases is not dissimilar.

To promote diligence and good workmanship, and an effective control over the working parties, a revised scale of pay, ranging, it may be, from 3*d.* to 1*s.* 6*d.* a day, is necessary. Day, task or job work should be alike authorised at the discretion of the officer commanding the works. To meet cases of misconduct, and to maintain employment on the works as a privilege, men abusing this privilege should be liable to be transferred, until restored, to companies or regiments debarred from such employment; and a clear distinction, both in duty and in liberty, should be maintained between such cases and that of others likewise not upon the works, but that from choice or from honourable causes. There should be besides a clearly defined system of promotion to the positions of master tradesmen, and to duties of superintendence and design. Both in rank, by warrant, and in the higher grades of non-commissioned officers, and in pay, these positions ought to be made as well worth attaining as is properly called for by the duties to be performed. The effect of such a warrant and of such new regulations upon enlistment can scarcely be questioned.

At the same time, no additional expenditure would be incurred, because it is proposed that the military, as well as all other expenses of the men executing the works, should be defrayed from the cost of those works estimated according to the present system, and from the expenditure now incurred on the existing system of supervision. On the other hand, it is not intended that the whole reduction that might ensue through the substitution of a military system, should be treated as a saving; but that a proportion of it should be devoted to preparing for its extension and for perfecting its application, as well as for ensuring a due remuneration and a sure prospect of advancement to those who qualified themselves in its several gradations of duty.

With the exception of the very small present number of Royal Engineers, no account is taken of military labour in the strength of the army voted in the estimates. That strength is determined entirely on other considerations. Accordingly it is not proposed to entrench for the performance of the additional duties occasioned thereby upon the force deemed necessary for other purposes; but, as has been explained, the army would be added to to an extent equal to the number of men required and found qualified and available for the execution and supervision of works. Probably it would be best in the first instance to add the increase of effective force thereby obtained to the existing companies of engineers. That body is, as has been shown, not only disproportionately and disadvantageously weak in point of numbers, but the advantages and prospects that would be thrown open to first-rate artificers through the expansion of the system of the military execution of works, would enable not only the number, but also the qualifications of that body to be raised more and more, both to a higher standard and to a more uniform attainment of that standard

In its degree it is an object almost as important to impregnate the

whole army with the spirit of work and of well grounded self-reliance, and to extend as far as possible to the whole that general aptitude for the emergencies of war, and to throw open to the whole those advantages in time of peace, that have been already considered. A real head-quarters for the Royal Engineers would almost be rendered necessary by, and might not be among the least of the advantages arising from, the military execution of works both in respect of duties of peace and those of war. By this means, among others, the high training received by the officers in early life would be maintained, and its effects fostered and turned to account through life. This head-quarters should also be the resort of other officers, and, at stated times, of other troops, who should be collected for joint operations by the several branches of the service, on a legitimate and proper scale.

It may admit of question whether the addition of the labourer's part should be made, except in limited proportion, in the same manner, or embodied in additional regiments or in special companies of Engineers, or attached to that corps. A mere numerical addition to the army would seem sufficient for the purpose. The authorised adoption of the system would lead, as to a natural consequence, to the stationing of a proportion of troops, with especial reference to works in execution or requiring maintenance (more particularly at the larger stations, and always, be it remembered, free of additional expense). This would enable working parties to be habitually drawn from regiments without in any way diminishing the strength at present concentrated for purposes of joint drill, and by adopting the principle of time and of rotation by regiment, company, or squad, according to the nature of the case, without disintegrating any sub-division of that force. It would also extend to every regiment, according to the use it made of the opportunity afforded, a portion of the advantages thrown open. It might be advantageous to both officers and men to draft the men taken from regiments into companies temporarily attached to or amalgamated with the Royal Engineers, particularly when their services were wanted continuously, or that they were partially qualified for skilled labour. On the departure of regiments from a station, or for foreign or active service, the trained men might be returned to the regiments, or not, by the decision of the Commander-in-Chief, according to the destination and the nature of the case. The deficiencies caused by the temporary or permanent transfers having been meanwhile filled as is now done in similar cases on a limited scale, the numerical adjustment would be maintained on the return of the trained men by the withdrawal of an equal number of men who had not been upon the works. The services at minor stations might be readily performed by an organisation similar in principle to the Coast Brigade of Artillery; so also as to barrack damage and hospital repairs and a great deal of store charge, at a great reduction both of cost and of complexity of arrangement.—[See Appendix B.]

In closing these remarks it may perhaps with propriety be added, that scarcely under any possible conditions could an accession of strength derived from a costless increase in the number, and from an aggregate improvement of the individual members of an army, be of

greater importance than in those which form the actual circumstances of Great Britain at the present time, with a comparatively small amount of population, an enormous and wide-spread territorial empire, and upholding and dependent for her very being upon principles of conduct alike removed from despotism and from anarchy, in the support of which she stands almost or entirely alone. Since she maintains, moreover, an increased military force, and incurs an increased expenditure for military purposes only under apprehensions of unusual magnitude and severity, the difference should not be forgotten, both as regards the country and the men themselves, between large bodies of men returning to the civil avocations of life (whether under the operation of limited enlistment or upon reduction) who have either become, as it may be feared is too often the case at present, in a great measure unfitted for all but the habits of the profession they have quitted, or who under the system proposed will have been exercised in various branches of industrial pursuit, and who not improbably will have become better citizens and subjects than they were when they first adopted a military career.

Lastly, I wish to say but a few words, not so much with a view of seeking to refute objections, as to prevent objections being raised on misapprehensions through want of explicitness on my part.

My proposition is, that it is better and cheaper to do military work by military than by either civil or mixed means.

Better and cheaper, among other reasons that have been already advanced, because two ends, as it were, are then accomplished by a single means, for officers and non-commissioned officers perform the military as well as the structural functions of their respective offices, whereas now two means, one military and one civil, are employed to attain, or it may sometimes be, to obstruct a single end. All expenditure incurred would tend at once and directly to its immediate end, and to the final end of all military expenditure whatever, viz., fighting power.

My illustrations are taken from existing facts.

My reasoning is limited to advocating the doing on a larger scale, what has been proved to answer under restrictions and disadvantages, nevertheless, the suggestions I have now had the honour of submitting to your consideration have not been hastily formed or adopted: on the contrary, they embody convictions and opinions the result of my whole length of service, such as that is. Neither have they been thought on, elaborated, or brought forward in any partizan spirit or personal interest.

They are not advanced for the sake of benefit to either Engineer officers or men, although I believe, if adopted, they would have that effect and that tendency.

It is not so much in even the interests of the army at large that I wish to bring them forward, as because I believe them to be founded on plain and simple, but, at the same time, powerful and important principles, and that they would have the results I have stated. I respectfully urge upon you their consideration, chiefly because whatever would increase the positive efficiency and the numerical strength

of the army with less rather than with increased expense, is, more especially in this eventful era, of interest and importance to every Englishman and to the whole country.

If I am right, moreover, in my strong conviction, that industrial training and practice are calculated to make the soldier a better subject than he was before, I do not think that the improved esteem in which discharged soldiers would then be held, and the reactive and insensible influence of this again upon enlistment, and so upon the army, ought to be forgotten.

In claiming, therefore, through your influence the consideration for this subject which I believe it to merit, I am peculiarly anxious not to be in any degree misunderstood.

I can imagine objections almost without number; but they are objections founded on an incomplete view of the whole.

It might have been assumed that I sought to benefit the corps interests of the Engineers, and so indirectly my own. I do not acknowledge the charge.

It may be said, I give a preponderance to the army at the expense of doctrines of political economy. The supposition would be, I believe, equally fallacious.

The military works wanted are but works wanted by the country, and necessarily supplied from its resources. The artisans of the country can then be nothing injured by a proportion of them being induced by advantageous terms to yield military service as well as their skill; but powerful inducements to good conduct, acting on a numerous class, must benefit the community at large. The opposition that has on occasion been raised against military labour is, in truth, far more opposed to common fairness as well as to sound political economy, and has in it far more of the spirit of dictation, of caste, and of self-seeking. It is an attempt on the part of powerful sections to prevent others from the exercise of the same crafts and of the like abilities: a spirit and an attempt that ought to be refuted and discountenanced, and not yielded to or encouraged.

Should it be said on the part of the army that its members enlist to fight and not to work, I can have laboured to very little purpose if I have not made it clear that all my aims and endeavours are to refute the spirit of this objection; that it is my whole object to enable the army to fight to better advantage,—to increase, as I have said, its fighting power in respect both of number and of individual and personal efficiency.

If it be said by any of my military brethren that I have sought to add a new and onerous duty and responsibility to our present labour, I must not and I do not wish to deny it. Carrying out work throughout, from its first design to its final completion, is a very different thing to supervising contract work with no interest in the men and no responsibility in the work beyond that of approving or condemning what others have to do. I have not sought to make Engineer duties more light, but to suggest a Constructive Service soldierlike, efficient, and complete for every part of the constructive duties required by the army.

Possibly some civil engineers, all of whom do not, I fear, display at all times the candour and courtesy towards their military brethren which, I trust, they invariably receive themselves at their hands, may be disposed to dispute the capabilities of the military service to furnish the requisite ability or the technical knowledge. I trust I have sufficiently met this point by that part* of my paper which deals more particularly with it, in the system of training and of gradual substitution not to have now to institute comparisons, nor to press the general qualifications of a body to which I have the honour to belong. I prefer altogether to waive this point, not caring to discuss it, because it is not essential to the subject. No one, I presume, will dispute that a military body may be formed capable of doing all its work, even were there no such thing at present. Moreover, it must certainly be conceded that this straining for assumed excessive technical attainment scarcely seems to be countenanced by the high authorities whose decision determines these matters, at least as to that part of the duties under consideration that relates to maintenance, and is now done by civil means, inasmuch as precisely the same kind of work which, if done as an Engineer service, would be subject to the technical skill and complex machinery of that department, is deemed sufficiently provided for without either one or the other when entrusted to barrack-masters or purveyors instead.

The civil assistants now in employment may be disposed to view with little favour a proposition for nothing less than the eventual abolition of their order; but all their interests, present and prospective, are carefully preserved and their services are retained, only they are placed to the best advantage. There can be no question as to procuring military substitutes in the manner proposed, for they can be obtained already. Some at least of the existing military foremen of works taken from the Royal Engineers are more than ordinarily efficient, and will bear comparison with any other class most favourably.

My object, as I have said, is not to advance corps interests of any kind, but to see army constructive services effected in what I believe the best manner possible. Just as these can be best performed by an entirely military organisation, they would, so done, form so excellent a school of military adaptability and efficiency of all kinds and for all grades, that a twofold injury is inflicted when they are not so done, and such a school is practically lost. Certainly under a different system the talent that may lay dormant till it die in the corps to which these duties are deputed in whatever manner to be performed, might be turned to far better account; but I have not stopped short with this aim. Could my wishes carry any fulfilment with them, they would be very earnest that the supply of all the soldier's wants should be deemed an essential and indispensable part of a soldier's duty; and if a better or a worse decision than is made in other countries shuts out from the hope of honour and distinction by far the greater proportion, if not all, of those to whom these duties are now allotted, a remedy reaching farther than the disease itself would be, to open the school

* See Appendix.

instead of the preferment, and to train in the school of meeting these requirements, those who are destined to command and lead to victory the masses, of whose wants we have been treating, and whose work they ought to be; in other words, the point I seek to establish is this, that its constructive services are properly the duty of an army and an invaluable military school.

The CHAIRMAN: Gentlemen, Colonel Synge has not only offered to answer any questions that may be asked him, but he has invited a canvass of his opinions; and we shall be very glad to hear if any one objects to or offers any suggestions on that which he has brought forward. I hope we shall have the benefit of the opinions of experienced officers upon this subject, which is one well worthy of consideration. Colonel Synge has modestly laid claim to no originality, but he is the first to offer a solution of two of the great difficulties of the day with respect to the army, namely, the questions of marriage and of limited service. He has shown us in what manner these difficulties can be overcome with benefit both to the soldier and the state. His opinions are supported by the fact that the pickaxe as well the sword have been said to be the badge of the Romans' conquest. The greatest military power in the world employed their men upon what we call civil works in times of peace; and the consequence was, that they were sounder, hardier, and healthier men in time of war. The latter portion of the paper is so much connected with the Engineer service, that if there is any officer of the Royal Engineers present, I hope he will say a few words upon the opinions of a brother officer.

Sir HARRY VERNEY, Bart., M.P.: I came here this evening hoping to hear the opinions of engineer officers who have had the same kind of experience that Colonel Synge has had. For I feel it to be of great importance to those who may advocate the employment of military labour, that, when the Army Estimates come on in the House of Commons, they may be able to say they have heard statements from those who have tried the system, that not only the employment of military labour will not interfere with military duty, but that it will render the army altogether more efficient. I entertain no doubt of that myself, and I hope to hear military men speak from their own experience to the great importance and value of so employing soldiers. One great object of the present day is to render the soldier as moral and as good a citizen as possible. I confess it is my ambition to see the day when the return of a soldier to his native village will be hailed by all the respectable inhabitants as an acquisition; when, instead of returning with something of the character that Colonel Synge has described, he shall return a much better member of society, coming to practice in his native village the trade he has learned in the army, and able to earn a respectable livelihood. In this way he will hold out an example to younger men that they cannot do better than enter the service; in short, holding out an example which the most respectable men in the village will be inclined to follow. I feel the great importance of this, for I heard it stated by a military man of great experience, a few days ago, that the men who are now coming into the army are less respectable than they were a number of years ago. It is owing to this, that almost all occupations are so highly paid now, that young men find they can do better for themselves than by going into the army. But if by entering the army, they are taught some trade, their opinions would be different; and I really think in this way a higher class of young men might be induced to go into the service. The gallant gentleman who has read the paper did not advert to the different occupations in which a soldier's labour might be employed. I recollect the last time I went over a French barracks, the officer who went round with me took up a soldier's shako and said, with the exception of the eagle on the shako, the whole of the soldier's dress is made in the barracks. Accordingly we went into one room, and there we found tailors at work; and in another, shoemakers; in others, all sorts of trades and occupations going on; and in the last which I entered, there were a number of Frenchmen dancing and pirouetting as hard as ever they could. They were jumping and performing all sorts of antics; I could not help thinking that I should like to see

our fellows doing the same thing. I then went to stay with an old friend of mine belonging to the French army, who had 40,000 men under his command. He said each thirteen men had a space given to them with poles and rafters, and they were allowed to cut their turf coverings for their huts, and to construct them as they pleased. Some of them built their huts upon two stories, and so they had rather more space for a garden; others built their huts on one story; and in almost all cases there were maps and sketches and all sorts of things done by the private soldiers, with which they had ornamented their huts. It evidently gave them a great deal of amusement, and a great deal of very useful occupation. With regard to the expense, I must mention what I quoted in the House of Commons. I think it was Major Buckley, the barrack-master at Chatham, who stated in his reply to the queries put by my honourable friend on my left, General Craufurd, that when he was in Jamaica, about thirty years ago, he built a target which had been constantly used ever since. That target was found to require some repair, and the repair of it alone was estimated at £200; whereas all that it cost him, and all that it cost the country, was three dollars in the construction. He employed the men under his command in the work. That shows how important it is to employ these soldiers in service of this sort. For my part, I believe the more they are employed the more popular the service will become, and the more efficient and the more respectable, and the greater the advantage which will accrue to the country at large.

Lord RANELAGH: I quite agree with the honourable gentleman who has just spoken, and I must say he has added one word that is the most important we have had to-night. That word is "trade." If we could introduce the system in practice in the French army, and make every man learn a trade, it would be a great benefit. But I cannot agree with what has fallen from the gallant lecturer, that there is the slightest chance of soldiers being employed on what he calls military works. I will ask him to illustrate more than he has done what he means by military works. I would put it to him in this way: What are those military works that he contemplates, and how are the men to set about them? I do not mean the mere digging of trenches, and throwing up earthworks for batteries. He goes beyond that. I would ask him how he would employ a regiment of Guards, and how he would employ a regiment of the line quartered, say, at Portsmouth?

Major LEAHY, R.E.: I rise with very great deference to observe that the question has not escaped the attention of the authorities. At the present moment, there are extensive military works being carried on exclusively by military labour. I allude to the new fortifications; they are being carried on under circumstances which when the proper time arrives, will enable the country to determine the value of that kind of labour. Under the suggestion of Sir John Burgoyne, with the approval of the Secretary of State for War, and with the encouragement of the Commander-in Chief, some of the military works at Dover and at Portland, are being carried on exclusively by military labour at the present time. A large work of the estimated value of £80,000 was commenced by contract labour. Circumstances arose which rendered it necessary to terminate that contract; the whole of the plant was taken over, and the department set to work on their own account. At the present time there are two companies of Engineers and a company of the line employed in carrying out about three-fourths of this work; and—I cannot speak exactly to the figures—a very large saving is being effected in consequence. In a similar manner, at another station, a company of Engineers, assisted by the Royal Artillery, and by the Line, have been employed carrying into completion a work which was commenced by civil labour. An exact record is kept, and it shows that a considerable saving has been effected, owing to the fact that military labour is paid at a less rate than civil labour. I have no doubt these facts will be brought under notice at the proper time; but I mention them now, in order that the meeting may not suppose that the question has escaped attention.

Major EWART, R.E.: It is well that an explanation should be made with regard to what has fallen from Sir Harry Verney, and relative to the comparisons which have been drawn, and which are constantly being drawn between the French service and our service, in respect to the question under consideration to-night. It must be recollected that the French service is dependent upon conscription; the consequence is,

that you get into the service a very different class of men from what you do in this country. In this country we have to go into the labour market, and to raise our men by money. It is a matter of pounds, shillings, and pence. In France they draw men of all classes, and they accordingly get into the ranks carpenters, tailors, bricklayers, shoemakers, and tradesmen who have been apprenticed before they come into the service. The great difficulty with us is to induce men of this class to come into the ranks. Taking an ordinary regiment, you find a very small proportion of what you call tradesmen. In recruiting for the Engineers, although we get a certain proportion of steady tradesmen, yet we get a large proportion of unsteady tradesmen. That is another difficulty we have to contend with in our service. If you employ men upon military works, you may have men who are very good carpenters and very good bricklayers, but you find many of them are drunkards, and you are obliged to send them back to their ordinary duty—you cannot continue to employ them. These are circumstances that ought not to be lost sight of in comparing our service with the French. The question of the great expense of the English soldier compared with the expense of the French soldier was under discussion in the House of Commons the other night. All that is dependent upon this consideration, that you find in the French service tradesmen of all kinds who may be employed at a very small remuneration. That cannot be done in our service, for the reasons I have stated. With regard to the subject of extending military superintendence, which has been mentioned to-night, I think the system in the French service of *corps-de-génie* answers extremely well, and I know no reason why it may not be extended in our service. Within the last two or three years we have introduced a class of military foremen, taken from the non-commissioned officers of the Royal Engineers, who are doing the work which is done in France by the *corps-de-génie*, and are doing it very well. In the French service they are substituted for civil clerks of works. A material improvement is going on in our army, as is shown by the works now being carried on. I may mention my own experience. I have had experience in the employment of troops in the colonies, in the camp, and in the field; and I have carried on the whole repairs of a camp in this country by military labour.

The CHAIRMAN: I don't know whether Colonel Synge adverted to the quality of the soldier with respect to saving. I think if the savings bank returns were referred to, it would be seen that our soldiers upon the very limited amount of pay which they receive are generally speaking more a saving class than the artisan who is in the receipt of very high wages. It is proved by the Savings Bank returns that our soldiers actually do lay by more money in proportion to their limited pay, than the artisan does out of his highly paid labour. As the advantage of industrial employment has been adverted to, I am induced to say from my own experience that it produces a very beneficial effect. My own experience is on a small scale, being limited to the staff of a militia regiment. The men are all employed, and they are all the happier for being so. There are a number of useful trades carried on in the regiment, to such an extent that the whole of my clothing store has been filled up by my own men. The consequence is, that what was estimated at a very high rate has been done at a very small one; and the men, who would otherwise have been in the neighbouring public-houses with nothing to do, are as happy as if they were all in one family. There is not only something to give them constant occupation, but there is something to take pride in; they take a pride in all these works, as much as if they really belonged to themselves. The trade of book-binding is one that has created so much interest, when some novelty happens to be introduced, such as a photograph book of a new description, that I have really had a greater demand upon my men in the book-binding department than they could comply with. This, I think, proves that we shall meet with success if we give encouragement to industrial occupations.

Lord RANELAGH: That is not military labour.

The CHAIRMAN: That is quite true. Colonel Synge will now be kind enough to answer your objections.

Colonel SYNGE: May I ask if any gentleman will speak upon the financial aspect of the question. Some elements of that kind have not been noticed, and there are gentlemen present perfectly competent to speak on matters of finance.

Sir Harry VERNEY: I may take the liberty of stating for the information of gentlemen, that only two days ago I waited upon the Secretary of State for War, in order to arrange with him a Return to be moved for in the House of Commons, to obtain the very information which has been referred to; namely, the number of men who had learned trades previous to enlisting, and the number who have been employed in their trades since they have enlisted.

Lieutenant-General CRAUFURD: I think there can be no question that the employment of soldiers of the line on military works is perfectly feasible, and not open to any objection whatever. I was stationed at Dover for a considerable period. One of the regiments of the line was employed in works of construction there, and I heard from the officer commanding them that they were men from the mining districts, and that they made themselves particularly useful. With regard to the proposal of Colonel Synge, that the men should be encouraged to marry, I must say that I differ from him with respect to that. I do not think it would be desirable to increase the number of married men in the army. Still, I have no doubt when a man makes a good marriage, it improves his character very much. We shall never have in the English army men already instructed in trades; but we may induce young men, who aspire to improve their circumstances, to enlist into the army in the hope of being instructed in a trade after they have enlisted, so that they may be able to get their livelihood by it after their term of service has expired. They will return to their communities with their characters raised, possessed of the means of earning a respectable livlihood, and they will thus be objects of congratulation to the communities from which they have sprung. If very young men enlist, the term of ten years will be a time of probation to them; they may be instructed in trade and may save money; and when they return to civil life they will still be young men, and can marry then, with much greater advantage to themselves than if they were to marry while in the army. For my part, I should be sorry to look to the promotion of military works by the soldier, with the view to increase the number of married men in the army.

Major EWART: I am afraid the difficulty we find now in one respect will be increased. If they are taught these trades, the difficulty will be to get the men to renew their enlistment. It is clear we shall want to hold out greater inducements to get them to remain.

Major LEAHY: It may be interesting to observe that in the Belgian army the soldiers are enlisted for two years only. A large section of the works at Antwerp have, however, been carried on by military labourers; and those military labourers have not enlisted as trained artificers. They have not only been employed on the works, but during the winter season they have been taught trades which in the summer season they have carried out in practice. So that in our service, with the encouragement which the employment of military labour now receives from the authorities, I apprehend there will be no difficulty in extending the system much more than has hitherto been the case. As a means of carrying it out, I quite concur with Colonel Synge, that military superintendence is essential to the employment of military men.

Colonel SYNGE: I have been unexpectedly gratified with the discussion. There are several points that have not been discussed that I wish just briefly to recall to your attention, because I am disappointed at their not gaining more attention. One is the financial aspect of the question; and the other, that which has been so forcibly pointed out with reference to marriage. With regard to the financial question, what I want to impress upon you is this, that by the course which I propose, we can relieve the Quartermaster-General's department of many of the financial difficulties which arise, I believe, in consequence of the present system of carrying out military works. Upon the question of marriage, I may shortly say that for many years I had been convinced of the soundness of my views in every other respect: but I never ventured to bring them forward, nor did I ever see the completion of them, until a casual remark was made to me with respect to the question of marriage. I must say that up to that time my own prejudices, my own views of the matter, were completely against marriage. I found everything else clear; but then the question arose, "What is the man to do with his money?" and I thought

it would only increase existing evils. I went into the subject in conjunction with those deeply interested in the improvement of the married soldier's position, and in all the circumstances connected with it; and it then appeared to me that a wider permission to enter upon marriage offered a complete solution of the difficulty. I may say, it is the keystone of the arch. Another point necessary for the complete cohesion of all these several parts in practice, is the training of the officers. What can illustrate the usefulness of training, through the execution of the works which you require for the army at all times, for a body prepared for service in the field, more strongly than the absolute necessity for there being such a body? How are you to train it better, and at less direct cost, than in the constant and complete provision of the wants of the army? What can show more strongly the incompleteness of the present system than the fact, that a vast proportion of the body now so trained is not available for military service? What I particularly want to bring forward is, that constructive duties ought to be the training school of those who are the fighting men. That this is consistent in principle, and cheap in practice. The noble lord near me has asked, What are the works which you wish to put them upon, and how is the work to be done? I maintain that everything that is required by an army, whether for its maintenance or for its duties, is a military work, and should be attained and carried out by the men who fight. The soldier may be likened to something like a snail; he should carry his house about on his back. Under his great coat he carries his knapsack, and in that knapsack is everything he wants. Now, as far as possible, I would have each man comprise within himself the ability to supply all his wants, and to perform all his duties, so that if you took the individual soldier, a unit as he stands, you should not only have a man who is to be shot at, but rather one who is superior to others, and able himself to supply all he wants as he goes along. Then you have a real soldier. And I believe ten such soldiers would be worth twenty that could not. That is my opinion of a soldier. It has been said that victory hangs on the side of large battalions. I say, rather, that victory attends *strong* battalions; efficiency, and not *mere* number. So that I mean by military works, everything a soldier wants, everything that is rendered necessary by his business; all this should be met by one who is a soldier. The subject hangs together. If you want to have efficient men who can meet all that you require of a fighting man, train them and employ them in the daily meeting of these requirements, whether in time of peace or in time of war, and you will have it: and do not go to an enormous expenditure for extraneous things, when a system of simplicity will meet it all. The War-Office expenses have increased 33 per cent. in two years, probably in a measure owing to the Indian amalgamation; but it is a very large expenditure, equal, as I have stated, in clerks alone, to 42 companies (4 battalions) of fighting men. I hold in my hand a letter, which I received from a person well-qualified to speak upon what he writes about, who adds his testimony to what has already been justified by other speakers, that where non-commissioned officers superintend the works, and soldiers execute the works, the result to the country is very favourable, and causes a large saving, and he sums up the whole matter in this way:—"There is no doubt that our army might be profitably employed in many ways with great advantage to the country." I have letters also from officers who have been employed in this manner almost on active service, to the effect that they have performed works in Canada at one-fifth the expense that they would otherwise have cost. I have known of cases where the saving on an annual sum amounted to one-half. As for increasing the proportion of married men, I do not think it will have that effect in the existing numbers. My proposal includes an increase of the combatant force equal to the number wanted for military works; and though I wish to increase the privilege of marriage very largely, yet to give an opportunity to a man to marry at his own expense, is a very different thing from throwing all the expenses on the Quartermaster-General's department. I concur in the difficulty that has been brought forward with regard to trades. I did not speak of trade being an advantage to soldiers as civilians; it is not my view to bring a man into the army, and teach him a trade, that he might then go out of the army again. That was not my view. Probably the House of Commons would veto a proposal for money to teach men a trade to be carried on in civil life; but my point is this, that by the present system

we are positively prohibiting men from the performance of their proper duties in their own business. A remark has been made on the difference between the French and English armies. But it does not apply exactly to the subject in hand. I have not referred to the French army, because comparison with the French army would not apply; but I know another instance, that rather corroborates the statement that has been made with reference to the works at Antwerp. I have known, not soldiers, but I have seen some two thousand and odd boys and men brought into prison at the time the system which drove men mad, of solitary and waste labour, was in competition with the natural way of dealing with that question, namely putting men to work. This latter course was then attended with a great deal of difficulty. There was a great deal of difficulty, in a case in which I know the facts myself, in contending with the prison authorities who were entirely against employment on works. But there was an arrangement made that gave a man a little more to eat. They were not at that time fed up to the masthead and made riotous, as they have been since. They were really well nigh starved, and these men were induced by the stimulus of a little more food to apply their latent skill. The late Lord Raglan was at the time about to go to the Crimea; and Sir James Graham performed in his place a tour of inspection. He was struck by the excellence of the work performed, after a very short time of training, by men and boys who a little while before had been Irish pickpockets, or criminals of a still lower grade. The old work had been justly considered model work as performed by contract, but that done by the convicts was as good. These were not soldiers who were taught to do the work; they were simply Irish pickpockets, whom the convict authorities of the day, moreover, drafted off to other places as fast as they could. That shows strongly that a soldier could do far less difficult work to great advantage, if he had a chance, although, happily, no conscription gives us a compulsory admixture of skilled men in our army. The substance of what I contend for is, that there are certain things which a soldier needs, which are not now put upon himself to meet, and that they ought to be imposed upon him; and that doing so would benefit the soldier, the officer, and the country, and in every possible aspect would be a benefit. The whole coheres; turn it in what way you may, it presents some advantageous feature, whilst the proposal is as simple as can be.

The CHAIRMAN: I am sure I shall be only expressing the opinion of the meeting if I convey your thanks to Colonel Synge for the interesting lecture we have heard. We are the more indebted to him, because the lecture has given rise to a very interesting discussion; and I think we ought to include in our thanks those gentlemen who have kindly taken part in the debate.

APPENDIX A.

Such, accordingly, appears to be the principle of the existing organisation. In the regulations furnished for the guidance of the corps in the performance of the duties allotted to them, it is laid down that "the direction, control, and responsibility is in the commanding engineer," and he is enjoined so to carry on the duty that "the whole distribution and detail of the execution of every service is to be conducted" under his own direction, with the direct object (which is expressly stated to be that of every regulation in the routine and detail of duty) "that the junior officers may have every opportunity of being fully instructed so that they may become competent to discharge the important duties of commanding engineer when that situation shall devolve upon them."

It is added that observance of the rules laid down will *ensure* that the younger officers become "conversant with every part of the service in which they are employed, from the formation of the design and estimate to the final completion and measurement."

So far there is no mention of nor reference to civil assistants. They are named for the first time in immediate connection with the particular duties of the junior officers, and consist of clerks and foremen of works and of clerks. More recently the foremen of works have been amalgamated with the clerks of works, so that whenever mention of them occurs, the present reading would be a senior and junior clerk of works.

The position and duties of, and the qualifications which these civil assistants are required to possess, are severally defined as follows:

Clerks of works have, "*next to the engineer officers*," "the control of the execution of all works and repairs," "and *in the absence* of officers at a station, become responsible for the due execution of all works."

All measurements of work, and all receipts of material, are to be attended by an officer of engineers, a clerk, and foreman of works. The two former are required to keep their respective measuring books, in which each is to make his separate computations.

This summary, taken from the official rules, shows the office of clerk of works to be subordinate and supplemental to that of the combatant officer of Royal Engineers, to be held by one intended to act in the dearth of officers, competent to perform minor but still responsible duties requiring technical attainments, and to have been resorted to as an agency less costly and more easily to be procured than the military officer of higher and more special attainments.

The organised system is, moreover, evidently intended to afford a reciprocal check throughout the whole working and detail. This is, no doubt, a sound and practical principle, but it is of no value unless it be applied in practice; nor does it appear necessary to resort to a complex or a civil agency in order to attain its adoption. Matters militarily organised are invariably checked, but it is by a board of officers, by the association together in specified duties of different ranks, or of different corps, or of different branches of the service. Civil agency is not necessary to this end.

In practice, however, the check is usually wanting. The officer of Engineers is often "absent at the station," that is, is not available in sufficient numbers to perform his allotted share in the system of regulated check, so that, be the result ever so innocuous, the clerk of works is generally unchecked. The *employé* actually made use of is the one who, of the two, is at the least the more open to the force of any temptation that may exist. This may be wholly unattended with evil; but if it be, it forcibly determines that the extent of the intended check is not necessary as well as not attained.

The qualifications prescribed for a clerk of works are "the strictest integrity, activity, and attention, and a full acquaintance with designing, building, artificer's work, and the qualities of building materials of every description. He should be competent to draw with neatness and accuracy plans, sections, and elevations, and be qualified to give

detailed working plans for the different parts of a building; he must understand thoroughly how to estimate and measure work of all kinds, be acquainted with book-keeping, and write a good hand."

These qualifications form, to the extent at which they aim, good and varied acquirements. If united in a high degree, they form valuable professional attainments; but this summary, which may be taken as the standard or ideal of a clerk of works, does not contain anything at variance with military service. Integrity, activity, and attention are necessary to the performance of all duty, but they are emphatically military qualities, and they are to be found as conspicuously in the higher ranks of non-commissioned officers of Royal Engineers as anywhere else. Full acquaintance with designing ought to be the necessary qualification of an officer of Engineers, and forms, as has been seen, the whole or main object of his training in the routine of professional duty. So also with regard to the principles and practice of building, and a general acquaintance with the qualities of building materials and the higher descriptions of drawing. That full knowledge of the minute details of building, and of artificers' work, and that intimate acquaintance with the various materials employed, which are essential to the perfect execution of work, can never, as a rule, be so thoroughly concentrated in any one class as they will be separately possessed by master tradesmen in the several branches that enter into the requirements of military service, and the position of a master tradesman of very high qualifications is entirely consistent with that of a non-commissioned officer of the higher grades.

Clerks, according to the regulations, are to be between twenty and forty years of age, to possess respectability of character, to write clearly, legibly, and quickly, with correct spelling and grammar, and to have a perfect knowledge of the first four rules of arithmetic, of Reduction, and the Rule of Three, of Vulgar and Decimal Fractions, and of Duodecimals. As to office work, they are to assist the clerks of works, whose time is to be rendered as available as possible for outdoor duty.

The correspondence of a large office, if that correspondence be necessarily large, or if the duties be confidential or important, ought to be under the charge of an officer; but if it consist only of the minor duties of clerks, or of what the Regulations term "mere office work," these duties clearly fall within the capacity of many non-commissioned officers, or even of men in the ranks.

So far as this civil element may have been resorted to from motives of economy, it can scarcely be said to have been eminently successful. Its cost is by no means insignificant. By reference to the army estimates 1864-5, it appears that there are 19 clerks of works, 83 clerks, 90 temporary foremen of works, &c., representing, with the various allowances, altogether an expenditure of about £74,183, besides rations equivalent to those of upwards of 100 men. An expenditure as nearly as possible three-fourths the amount voted for the whole existing companies of Royal Engineers, and which, with the additional sum of £3,394, expenses in the office of the Director of Works for surveyors, draftsmen, and clerks, amounts to upwards of 8 per cent. on the whole

votes for works and buildings for subsidiary and subordinate assistance, exclusive moreover of the proportion of the £125,055 for clerks in the War Office that may be employed on duties arising from the same votes, which amount for clerks only in the War Office is some £15,000 a year more than the cost of the 40 companies of engineers, and exactly one-sixth the entire expense for works and buildings of the whole imperial service at home and abroad.

Thus the regular employment of the officer of engineers, though carried on in all parts of the empire, brings him, unless he be attached to the little body of soldiers incorporated under the same name, everywhere alike into a round of duties, in the conduct of which he is associated with civil assistants, civil contractors, and civil labourers, in short, exclusively with civil life. He forms the sole, and he is often deemed the anomalous military, element of the life that surrounds him. Even if taste, liking, and zeal could in every instance rise superior to life-long habit, rule and circumstance, still it is obvious that the officer of engineers is in general placed at a disadvantage as impolitic as unfair as to the acquirement or practice of military aptitude and habit.

Impolitic, *because his military service is the essential object of his professional attainments.* He is liable to be summoned at any moment to duties that a soldier, animated by a soldier's spirit, only can perform. He may suddenly be called to be concerned in, or perhaps to conduct, the operations on which the safety of a fortress, the success of an expedition, or of a siege may wholly or in part depend. Unjust, because he is debarred from the attainment and practice of those qualifications that would enlarge his capacity for service, and from cultivating that aptitude and taste which most probably led him to enter upon a military life. The fulfilment of such aspirations he must, under present conditions, in general for ever forego.

In practice the extensive employment of civil agency is, however, productive of an injury more serious than any merely personal hardship or injustice.

The primary aim of the whole detail of the routine of duty is declared to be the training of the officer of engineers so that he shall, through personal and experimental conversancy with every branch of that detail, become perfectly fitted for the post of commanding engineer by the time he shall attain that position. Very frequently the junior officer is not under this immediate guidance and supervision by his commanding or senior officer, but is often called upon to furnish, as best he may, designs, plans and estimates for various services, and is ostensibly required to employ a degree of knowledge which his limited experience renders it, in fact, impossible he should possess; whilst, at the same time, the actual definition and subdivision of duties, laid down by authority, often puts it out of the power of his commanding officer to interfere at all with these duties in the course of their preparation, after he may have furnished his general instructions, until they are submitted to him in a state of comparative or absolute completion.* The commanding officer can then only transmit

* This is almost invariably the case at outpost stations where there is generally a very young officer, but an experienced clerk of works.

the documents he receives to the higher authority over himself, or return them, if absolutely necessary, for amendment to the junior officer, and so inevitably delay the service he is expected to forward; and, in fact, the junior officer has both been expected, and by circumstances forced, to appeal for professional direction or help not to his senior or commanding officer, but to his subordinate, the clerk of works, from whom, unless the strength of his own character have prevented it, he is more likely to have taken guidance also, than to have received assistance only. The work approved by the commanding engineer, that is to say, which has thus passed through his hands, undergoes a farther scrutiny under a superior authority, but by a civil revision as to the minutiæ of detail. In its lower stages this course is contrary to all military subordination, and at variance with the proper relations between the officer and the clerk of works. It can act favourably on neither one nor the other. Its practical effect also, is that the officer of engineers only has the opportunity of fully dealing with the whole details of his professional duty in all their minutiæ at a time when his experience and his youth are calculated to interfere, the one with the ability, and the other with the inclination of doing so with good effect and in good earnest. Throughout, that thorough conversancy and complete responsibility that might be otherwise obtained are frustrated. Whether the general qualifications of the clerk of works be good or bad, his technical attainments, if he have any experience, must necessarily be greater than those at first possessed by the young officer. Besides, if he be young or indolent, or conscious of deficiency, he may fall back with but slight risk of detection upon the technical knowledge of, and on the practical examination of the work wanted by the foremen of the very contractors to be employed in the eventual execution of the service under consideration. In point of fact, clerks of works do receive after their entrance into the service that very training at the hand and under the immediate supervision of their seniors, which the Regulations so pointedly prescribe for the officer of engineers. If exceptions take place to the course that has been described, it is owing to officers of Engineers taking upon themselves the duties of detail belonging to the clerk of works; but so contrary is the practice actually pursued to the official theory of the code of Regulations, that his doing so would not only not be sanctioned, but would under ordinary circumstances necessarily expose him to the censure of his superiors. Thus if the foregoing statements be accurate and admitted, the numerically strong, complex and very costly civil agency employed is not essentially necessary;—is needlessly expensive, and is calculated to frustrate rather than to foster that which is declared to be the aim and basis of the method of the entire prescribed system of duty; and if training for his future position in the manner therein laid down deserve the weight clearly attached to it by the Regulations, it were too sanguine to expect that its frequent complete negation in practice can have had no injurious effect in the instance of every officer who has risen to the position of commanding engineer without it. At the best, let them have remedied the consequences as they may, officers so circumstanced

have undoubtedly not had the advantages to which they were entitled and which the orders prescribed.

APPENDIX B.

The divergence between theory and practice in respect to the training of the younger officers of Engineers has been pointed out. So far as the object theoretically proposed can be met by any instrumentality it would be fulfilled by a military system. Were the minor divisions of Engineer commands abolished, and the current and special services as they arose allotted under the immediate orders of the Commanding Engineer, not only would a greater and direct responsibility be obtained, but the preparation of plans and estimates might readily be devolved on the junior officers under his immediate direction as laid down by the code of regulations; and, by entirely withdrawing clerks of works from the duties and offices of the younger officers, these would have only the legitimate assistance of approved non-commissioned officers, masters of trades.

During the continuance of the existing clerks of works, *whom it is proposed to promote in the same manner as now to the highest situations at present open to them*, they might with great advantage be attached to the offices of the Commanding Engineers charged with the duty of examining all the minutiæ of the details of services prepared by junior officers or by non-commissioned officers upon the instructions that had been given direct by the Commanding Engineer or his assisting officers. The younger officers would by this means necessarily become conversant with every branch of their duty, and that under the immediate direction and observation of their superior officers. Their qualifications and improvement would be daily tested, yet without needlessly encumbering the commanding officer with a burden of detail. As vacancies occurred in the establishment of clerks of works these duties should be performed by one or more officers of medium rank assisted by perfectly trained non-commissioned officers. The direct benefits to the service would be scarcely less considerable than those to the training of the younger officers. The services required might be performed more directly and with less back reference. *Waste labour*, which in *physical* matters is deemed the most severe of punishments, if not the most ingenious and cruel of tortures, would be greatly lessened. The multiplication of plans and documents, the copying and registering of correspondence and orders, rendered necessary by sub-divisional arrangements of duty, often at the same station, would be diminished, if not wholly abolished. By farther substituting for regulations which require the correspondence to be kept in books of "letters received" and "letters issued," a classification of correspondence according to station and subject, this simplifying may be much extended, and the information relating to any station or subject ascertained by simple perusal, instead of having to be "hunted up" by means of hieroglyphics referring through a multitude of ponderous volumes and perhaps

ingeniously elaborated to necessitate dependence on personal knowledge and individual inclination.

Similarly, by requiring perfect models or plans of every particular, and all information, properly classified and perfectly distinct, to be at *the actual working head-quarters* of every station, and nowhere else, it would always be known whence to obtain any information that might be required, and always practicable to obtain it without delay, and yet without multiform waste reproduction of the same matter.

This simplifying, and that is but another name for the combination of order, efficiency, and economy, might be usefully extended by consolidating the votes for the military constructive service, and abolishing the arbitrary distinctions of "fortifications," "barracks," and "store and other buildings," which compel a multiplication of the forms of estimate with all the accompanying papers, and which end only in obscuring the real military resources, requirements, and expenditure of any one post, and in making it next to impossible to collect them and view them in their merits as a whole. Another practical improvement over a figment often detrimental in practice might be gained by voting services absolutely, instead of conditionally on termination within the arbitrary period called "the financial year," whereby the gist of the whole matter, the actual execution of the work wanted, is often thrown into the most unsuitable season of the year, and contracted for and carried out under conditions unnecessarily disadvantageous, causing moreover needless and often perplexing labour in other words, useless expenses in supervision as well as in the contracts, for the time of its paid servants is the money of the State. It would be quite compatible with this proposal to limit the expenditure within the year as might be deemed requisite by considerations of finance. The evil arises from the practical work being subordinated to what may be likened to the convenience of the clerks taking stock, not from the fact of stock-taking.

In many respects the bases of military requirements are in a great measure constant; where this is the case at least the general arrangements may be grounded in common upon these requirements. For instance, the strength of a regiment of cavalry or infantry, or that of a battery of artillery, or of a company of Royal Engineers being determined, as well as the various items of accommodation that have to be provided in addition to the barrack room, such as shops, chapel, school, library, and recreation rooms, gymnasium, canteen, and the like, and the proportion of officers and staff, non-commissioned officers, and of married soldiers' quarters, the general arrangement and construction of a barrack should in each case be uniformly based on these constant requirements, which ought to be clearly defined in one consolidated regulation. Such a construction must be worked, as it were, outwards and upwards, not pressed by an arbitrary necessity, such as too small a space of ground, or the vote of but one-half the necessary money into conditions not to be reconciled. For example, the barrack-room ought to be determined not from an outward dimension, but by addition of its contents, from the dimension of the barrack bedstead, the space to be left between them, the air

to be breathed per man, the nature of the stove or fire-place, the best position for the arms, for shelves and accoutrement pins, the number of men it may be deemed on the whole most judicious to place in one room, and the effect of the position of door and windows on these particulars. The detail of the several buildings having been deduced from similar considerations, their relative position one to another, and to the parade, the drill or exercising ground has next to be determined.

It is obviously unnecessary to employ a numerous and expensive staff in repeatedly meeting these wants from limited experience and confined resources. Indeed many of the elements are necessarily arbitrarily fixed, and can only be determined by the highest authority. Under the existing system, the result of all experience must be concentrated at the War Office, and should long ago have caused the ideals of all such services to be, so to speak, stereotypes to be only so far modified, as might be necessary or beneficial from local causes. These modifications arising from intimate local knowledge, would be the proper subjects of scrutiny by higher authority, both as to conception and proposed execution; but it should be unmistakeably open to all commanding officers to bring to the notice of the superior authorities any suggestion they might deem an improvement deserving such consideration.

It is obvious, that from the aggregate of such designs as have been described, any one or more of the several parts that might be separately required, might be readily adopted; that is to say, precisely the same principles are applicable to the component parts of a barrack, and to all frequently repeated services grounded upon constant requirements.

Annexed are forms for the employment of military labour. They give a complete diary and check-book without any repetition of the services performed or of the nominal roll in the daily distribution. They comprise fully everything that can be required, and by the "Abstract" in the "Diary of Services in Execution," become the basis of a record or expense ledger, made by simple extract, which would show the expenditure for any given time on every building, or particular part or class of buildings, or on any special service, or on any post, station or establishment. They have been framed to meet the most intricate case (so far as mere book-keeping is concerned), that of maintenance by minor repairs executed on requisitions generally containing many items and often occupying only part of a day in execution. The same forms answer for all other cases, but fewer entries are necessary and fewer distinguishing marks among the entries.

Form I. The "Diary of Services in Execution," shows the service required in column I, specifying in its subdivisions A, B, and C, the locality or name of the work or building, the description of the construction or repair required, and the date of the service ordered.

Column II gives the item and vote or estimate to which the service is chargeable:

FORM 1.—Diary

Date of Execution.		Requisition or Authority.		SERVICES.			Chargeable to		DETAIL as EXECUTED	
									Materials.	
From	To	No. of Requisition.	Item on Requisition.	Locality or Name of Work or Building	Description of Construction or Repair required.	Date when ordered.	Vote or Estimate.	Item of ditto.	Nature, Description, and Quantity.	Cost.
										£	s
V		III		A	B	C	II		a	A	b

| ompany Royal Engineers. or ompany th Regiment. | | |

Column III, the requisition and its item in cases that the service is one performed on requisition.

These columns should be filled in immediately on the receipt of any order for the execution of a service; and are merely clerk's work requiring no technical knowledge.

Column IV shows by its various subdivisions A, a b, B, C, c d, and D the materials consumed in the execution of the service and their cost, by whom each part has been executed, and the cost of the labour expended at the regulated rates of pay, as well as the total cost of both material and labour. With exception of this last subdivision, which is merely the addition of other two, this column, as well as columns V, VI, and VIII, must be filled in by those entrusted with the superintendence and execution of the works.

Column V gives the date from the beginning to the end of the execution of a service.

Column VI, its cost as estimated at contract rates by civil labour.

Column VII, the difference above or below that estimate, of the actual execution of the work by military labour.

Column VIII is for remarks.

Column IX (A B) gives an abstract of all work done and of its cost, from which a perfectly accurate record may be kept (without any further trouble than that of noting it) of the expense incurred according to any classification that may at any time be wanted, however arbitrary; such as commanding officers, field officers, and officers, quarters, men's or married soldiers quarters, chapel, schools, libraries, recreation rooms, canteens, or gymnasia, walls, brickwork, masonry or wood, of boundaries or of buildings; roofs, slate, felt, or iron; stoves, grates, drains, roads, fences or what not, almost without end. One form and one entry contains the whole; nor is any other precaution necessary to its use than to avoid crowding the entries in column I in order that sufficient space may be left for the parts under A and B of column IV.

Form II. The "Weekly Check Book and Diary of Daily Distribution," the former framed to meet the regulation by which military working pay lists are made out weekly, and, with the latter, showing where and on what services each man is employed each day.

Column I gives the nominal roll, and after the entry of the non-commissioned officers, should be arranged by trades. Its subdivisions give the names, trades, rank, and regimental number of each man.

Column II enumerates the services in progress during the week, to each of which is given in the subdivision B of that column a distinguishing number or mark, which used in the appropriate part of the column (III) of the days of the week, shows the service on which the man was employed opposite to whose name it is placed on the day under which it appears. When a man has been employed only for part of a day, the fractional part placed under the distinguishing mark denotes the proportion of the day for which he has been employed on the service, which is indicated by the distinguishing mark or number. When he has been on more than one service in a day, the several distinguishing marks, with the proper proportion under each, will show

his whole employment for the day. Subdivision C of this column shows to what item and estimate each service is to be charged.

Column III contains the days of the week to be filled in as described in treating of column II. It also contains under each day of the week a subdivision for the initials of the superintendents. This initial, if unaccompanied by remark, inserted in the column for that purpose, is the certificate of him whose initial it is, that he is satisfied both with the quantity and the quality of the work performed by all those under his charge and devolves the responsibility to that effect upon him. By this simple method a certificate and report are daily obtained extending from the non-commissioned officer in charge of a squad or of any detached piece of work, or of any particular branch of work, through the several master tradesmen up to the officers in charge of works, involving a direct acknowledgment of personal responsibility throughout every portion of the work.

Column IV is abstracted at the end of the week, and shows the amount to which each man has become entitled, according to the days he has been employed and the rate at which he is to be paid per day.

It is obvious that task-work can be registered by the same means, showing in days, the value of the work performed.

Column V is for remarks by the different grades of superintendents as may prove necessary.

Column VI is for the amounts and items to which the whole expenditure of the week has been chargeable, showing the amount per item and per man. It must contain as many subdivisions as there are separate items of expenditure in actual progress during the week. This can be sufficiently foreseen to prevent, by an ample allowance, the necessity for any frequent repetition of the heading. Under each subdivision is brought out opposite to each man's name the proportion of his earnings as it is chargeable according to the heading of the subdivisions.

Column VII gives the account authorised for each service, and the mark of reference to the authority.

Column VIII is for the amounts expended on each service, both during the week, and total up to date.

Columns IV, VI, VII and VIII, are clerks' work. The entries on the lines in columns II, VII, and VIII, must correspond with one another, and those in columns I, III, IV, and VI; but the entries in the two sets of columns are quite independent of each other as to the space they occupy.

Form II.—Weekly Check Book

NOMINAL ROLL.				DAYS EMPLOYED.												ACCOUNT for the WEEK.					
Regimental Number.	Rank.	Names (after the Non-Commissioned Officers arranged by Trades.)	Trade	Monday		Tuesday.		Wednesday.		Thursday.		Friday.		Saturday.		Total Number of Days.	Rate per Day.	Amount.			Remarks
				Employed	Initials of Inspection	Employed.	Initials of Inspection	Employed	Initials of Inspection.	Employed.	Initials of Inspection.	Employed	Initials of Inspection.	Employed.	Initials of Inspection.			£	s.	d.	
Date																		For the Week			
I				III												IV					V

Diary of Daily Distribution.

SERVICES in PROGRESS.			AMOUNTS and ITEMS to which the employment of each man is chargeable during the week.												Authority quoting the Reference of the authority and the amount authorised.	Amount expended					
...the Column of Days employed.	Description (sufficient for Identification.)	Chargeable to.	Vote.			A. E. 18 ·/. It.			A. E. 18 ·/. It.			A. E. 18 ·/. It.				During the Week.			Total up to Date.		
			£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
from the th									to the th						18						
5	A II		VI												VII	VIII					

The advantages of these forms are the completeness and succinctness with which every particle of information connected with the execution of a service is entered and recorded without any repetition of writing, the consequent saving of time and of money in useless office expenditure, the complete chain of report and responsibility obtained in like manner, whilst all the information connected with the execution of every service is minutely recorded, ready and plain at a glance whenever it may be required for reference. The daily distribution for instance may be ready with the first morning parade, the distribution as appointed being entered in pencil and filled in with ink according to the actual event of the day, on the return from work.

The arrangements for the next day are also made at that time; the several officers, or non-commissioned officers in charge of works, or parties attending for that purpose at the engineer office, and receiving from the directing officer instructions already prepared according to the orders received during the day, as well as orders of delivery from the store charge for any material that will be required for the services in hand or to be done.

These delivery orders retained by the issuer become his vouchers to the commanding officer for the material thereon specified.

The receipt, custody, and issue of materials may be reduced to a very simple routine. The requirements of new or special services can occasion no difficulty. The materials required for these, necessarily appear in the estimates on which they are sanctioned, and have only to be ordered, received, and taken on charge before the work is ordered to be executed; those for minor services can be provided for without any delay by an order on the contractor for the probable consumption for a month, taking into consideration the stock that may be on hand.

By this means both delay in the execution of a service and too great, troublesome, or responsible a store charge are alike avoided. The receipts of material would be so regular and comparatively infrequent that all material so received could be strictly measured and examined as to quality by the properly appointed officers according to the intention of the present regulations, now often, as has been stated, neglected or impossible in practice.

The custody of materials is provided for, by the appointment of an officer or non-commissioned officer according to the extent of the charge.

Evening Meeting.

Monday, April 25th, 1864.

Captain E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAME of MEMBER who joined the Institution between the 18th and 25th April, 1864.

ANNUAL.

Mayo, J. H., Lieutenant West Norfolk Militia. 1*l.*

ON THE CONSTRUCTION, MODE OF APPLICATION, AND USE OF HIND-WHEELS: BEING A NEW FORM OF PADDLE-WHEELS WORKING UNDER THE COUNTERS.

By Major J. Scott Phillips, late H.M. Bengal Artillery.

Ladies and Gentlemen,—It is with great deference to the opinions of the Members of the Royal United Service Institution, as well as to the opinions of the scientific friends who have honoured me by their presence, that I venture to address this meeting, and attempt to bring forward a naval propeller, for which I solicit your favourable attention, while I endeavour to set forth its construction, its mode of application, and its claims for further notice. And as you have so kindly granted to me this favourable opportunity, I will not further preclude that which I have to say concerning this propeller, save merely to observe, that I have been making studies and experiments on the subject of propulsion for upwards of two years past; and were I not conscious of having devoted much time and pains to the matter in hand, I should not have ventured to appear before you. Before proceeding with my subject, I will just show the action of the common paddle-wheel by means of the model in the trough of water, seven feet long by two wide, before you, in order that you may have a clear view of the quantity of water which it lifts, and thereby also form some estimate of the power lost on entry; and though Morgan's patent feathering-wheel lifts very much less water, it loses some power

by the friction of its governing rods and their eccentric, while of course, like the common wheel, it cannot be carried out of the way of danger from shot and waves, or be applied with equal advantage to a sailing vessel. And I will mention that in the model fitted with *hind-wheels*, of similar diameter to the common midship-wheels before you, the hind-wheels (such being the most appropriate name for my wheels as will appear in the course of this paper) beat the common wheels by seven per cent. in speed, though I consider that as yet I have not been able to study ship-building so as to give to the hind-wheels their full advantages. After this necessary digression I return to the propellers fitted on the hind-wheels, which I wish to recommend, and which are made like the model which I hold in my hand, (Plate XIX, Fig. 4,) formed either by casting, or by fastening together two sheets of metal cut upon curves, to which I will presently allude, and folded as it were upon a certain angle, till the shape produced resembles that of a deer's or hind's foot.

In fact, the forward curved angle, if I may so express myself, of this propeller, is formed on a line which after marking the extreme circuit of the proposed wheel at seven equidistant points all round, and, as in Fig. 1, marking off the subdivisional points of seven radii drawn to the said seven points, will connect the semi-radial with the circumferential points; and on such points by such a line or lines, seven like propellers being affixed, (for I have found by experiment that the proper number of floats is exactly seven, that number giving a clear beat into unbroken water for each successive float) a wheel is formed such as I now exhibit, which cannot lift water—a fact of which you can judge most assuredly, if you will but kindly attend while I move the sheet of zinc cut to represent the inner flange of a hoof-shaped float over the face of the diagram (Fig. 1), which, representing a wheel with its proper water-line or dip, enables me to show that the front curve of the hoof-shaped float is so framed as by the said sheet of zinc, that this curve, and in fact the whole propelling surface, comes out of the water at very nearly, if not absolutely a right angle to the water-line. Now there being no other angle but the front angle in my propelling floats, I trust I have decidedly cleared my great leading fact, namely, that this propeller having no opposition at entry, its entry being covered, as you see, by the front of the well in which it works (see Diagram, Fig. 3), has, above all, no lift or breakwater on coming out, and this I will exemplify before your eyes by causing the hind-wheels to revolve at speed.

And now I would ask your patience while I endeavour to run through the preparatory subject of the water lines beneath and around the stern of a swiftly-progressing vessel.

Not to dwell upon the mode of that dispersion of the waters which is necessary to make way for a vessel at speed, I consider those waters as pushed aside and virtually dispersed to such a degree that they cannot furnish the necessary supply to fill the space beneath the stern; and therefore that space must mainly be supplied by waters rising up from underneath, of which we have what I venture to think is a very strong proof in the fact of chips and straws following a round-sterned

Pl XIX.

Frew.

JR Jobbins

vessel when at speed, pressed close against the stern by reason of that sudden welling up of waters from below, of which I have just spoken. Indeed, we may consider that of necessity the space astern between the side currents of displacement, will certainly in the largest measure be filled up by waters from underneath; because the beam in a vessel built for skimming rather than ploughing the deep, being equal to more than three times the draught, the side currents cannot close in as fast as the lower waters must rise; those waters also rising the faster, because of the pressure of the ocean increasing in proportion to the depth of the space requiring to be filled.

In speaking thus, I would not be understood as attempting to do more than merely indicate a general view, which will admit of great modifications, as by the stern build of vessels and the point and depth of outbreak of the wheels. But when we may be so happy as to see an experiment made with a vessel of 80 or 100 tons, a canal tug (such as could be built and fitted complete for £1,200) or an Indian river cargo boat, we shall be enabled to look between the spokes of a revolving wheel to "discover the channels of waters," to see distinctly how the inner or breakwater rises, the form which it assumes at different rates of speed, and so obtain more decided ideas upon absolute demonstration.

I have, however, been able to experimentalize in some degree, by placing a tin box without a lid and left open, on one of the smaller sides, in a strong current of water. For on sinking the box one-fourth of its depth, it became emptied of water, while the forms of the rising under-current, and the two side currents became clearly visible. And I would also draw attention to the drawing which I exhibit (Fig. 2), showing the rise and the side currents astern of a section of Mr. MacSweeny's ingenious connector steam-ship, when anchored in a four-knot tide. There you will perceive (though the illustration is an extreme one) the side currents only joining one another about 40 feet astern; while between them arises a tumultuous welling up of waters with eccentric curves; half of which rush towards the vessel, and dividing against it form two side eddies, which presently retire in a series of eddies to the general wake. These illustrations it may be of some use to consider, and it will then, if this theory be acceptable, be evident that there will always be under the quarter of any vessel in motion, and influenced by the vessel's build, a certain general line which may be termed the line of contact between the rising waters and those which are closing in; outside of which line the current is passing in swift curves to form the wake, and inside of which the waters from beneath are tumultuously welling up and rushing in a continued series of eccentric curves, part more or less against the vessel's stern, part to meet the side currents, and part astern into the general wake.

And here my propeller, may I say it, naturally drops in. Feathering as it were smoothly down, the outer flange of my hoof-shaped float gathers water from the outer current, and then embraces with full scope the waters of the inner rise, a point to which I earnestly beg your attention, especially in connection with the peculiar form of the

wells in which the wheels work as shown in diagram (Fig. 3); and as the propellers in swift succession meet with their curves the swelling waters of that inner rise, so they obtain in some degree the fulcrum of opposing waters, instead of driving, as does the screw amid waters, passing through it; or, as the midship paddle-wheels, through waters in some measure slipping past them. And now, if you will kindly observe, the propellers are so arranged, and the wheels carrying them are so placed, as to be thoroughly shielded on entry, and then so as to break out from the wells in which they act, feathering smoothly in to their work, at the precise point of advantage to make the most of the rising back and side water; while, as the propellers aid each other, they so keep back the waters that they have not only their inside gathering of waters to aid their fulcrum, but also the pressure of the waters heaped up from below. Nevertheless, the heaping or driving back does not affect the clear exit of the propellers (or floats), since owing to the mode in which each propeller is lifted out of the water, they do not lift water, leastwise (for these are not of perfect manufacture) but a very little; while, I believe, that by giving a slight twist inwards, as by the shape of a natural hind hoof (Fig. 5.); even this small amount may be obviated, and the propellers come out emptied to the smallest drop.

These propellers, however, have also, as I conceive, an additional recommendation when driven at high speed, which I may best exhibit after suggesting the query as to why it is that, while we can travel 60 miles by land in an hour, we cannot get a speed of more than 20 by water? seeing that we have an incompressible fluid to deal with, though contrasted with solid metal?

Now, the theory has been suggested to my mind, that as the incompressible waters must require some average time to allow of their particles acting against each other, and so of the masses being moved; it is but a question of time versus matter or driving speed, to convert the moveable yet incompressible fluid into practical solid; and, therefore, if we can construct propellers so strong, and so perfect, as to contain merely the elements of propulsion at a certain angle, with a perfect entry and no lift; and if such propellers can be formed to grip—I say to grip—the fluid for so long a time, and no more than is precisely needed; then, if we drive these propellers at a speed exceeding the measure of time which is required to set the particles composing water in motion, we shall drive as against a solid, and obtain transcendent results with corresponding benefits.

In support of this view, allow me to quote the able Editor of *The Engineer*, who writes concerning the benefit of quick driving under date February 12, 1864, as follows: "It may yet be found that "light quick working engines are superior in all respects to the vast "masses of machinery now placed in our vessels of war. It is per-"fectly well known that small engines, working at high pressure and "at quick speed, have far the most power for their weight. They "are too by far the best adapted for economical expansive working, a "fact proved by locomotive practice. With improved engines of "greatly diminished weight, and driven, say at 600 feet of piston

"per minute, and with twin screws (for which I would say, read "wheels), a great increase of effective power might be introduced "into our ships of war, and that, with a decreased weight of machinery "and decreased consumption of coal."

And so, I venture to think that, quick driving—if you only have but a proper machine—is the thing to be aimed at; and I suggest the theory that, with quick driving, and with my hoof-shaped floats, a positive grip may be obtained, which will avoid slip, and enable us over the waters to emulate the railway engines on the land.

An ordinary paddle float cannot grip the water, cannot be driven beyond a certain speed, but it forthwith lifts an enormous load of water, or scoops off the surface water, and is endangered by its own action, or actually loses power.*

The best screw likewise has no grip, the waters are passing off its surfaces continuously, while in both screw and paddle the driving surface power increases only as the square, while the hoof power increases in a measure as the cube.

For the propeller or float, which I have been permitted to bring before you (Figs. 4 and 5), containing, I repeat, the pure and simple elements of propulsion, without drawback, has, owing to the gradual contraction of the hoof shape (a most material point) a grip; at high speed will have a powerful grip, aided by strong internal friction, when, at a certain, and that a beneficial angle, slightly downwards, and I do hope that I may carry the consent of some present with me, when I beg to affirm, that were this but the merest theory, such theory would be worthy of a trial on a large scale; in the hope, if but in the hope, to grasp such transcendent advantages as a realization would secure.

To the gentlemen present I need not dwell upon the combined strength and lightness of the wheels before you, or point out that the whole working strain is thrown upon the inner-angle of each propeller in lines perpendicular to the radii of the wheels. And I will only, ere passing on to a brief summary of the advantages to be gained by their use, pause to note that these propellers have besides other analogies, a strict analogy with the propeller of the most powerful swimmer and diver of the web-footed tribes. I mean the cormorant, which, with his triple-webbed foot, overtakes the fishes with their finny tails.

In these feet I have found, by actual inspection, at the Zoological Gardens, on the 8th of this month, and in clear water, that when the

* Three days after the reading of this paper, having obtained a spring of greatly increased power, it was found that, on trial, the common wheels were whirled round so rapidly that, having scooped out a hollow, they merely produced a scattering of water aft, the vessel making no progress in the water, because the wheel-floats being parallel to one another and set on at right angles to the line of progress, could not get the needful supply of water to enable them to propel the vessel; while the hoof-shaped floats, entering without loss of power, being put on at consecutive oblique angles to the line of progress, supplied with water from within, and from without, and from underneath, and gripping the water, drove exceedingly well, the wheels revolving at a proper speed, and lifting no water as they revolved. Hence it is concluded that the discovery, as set forth, is now established and complete.—J. S. P.

bird is striking out, the inner web, as shewn in the Plate, of a triple-webbed foot, is thrown back, and the outer-webs are also thrown back, until the foot obtains the form of my propeller; and then the cormorant, with instantaneous strokes, amid the waters, drives as against a solid, and cleaves the waters like a flash of lightning.*

And, now, allow me to narrate the advantages looked for from the use of hind-wheels, throwing in such remarks as each may call for:

1stly. Being of strong construction, the force of stroke falling on the inner angle of each propeller, and being sheltered from shot and waves, they will scarcely ever need repairs, cannot get fouled, and will work with perfect smoothness. Dipping deeper than the common wheels, they are not so liable to be alternately rolled out and unduly immersed.

2ndly. If found needful, though I doubt the necessity, larger wheels can be carried than is usual, because these wheels dip so much deeper than the midship wheels now used, and can be made to sweep the full draught of a ship. Indeed, I have found by experiments with the model and wheels before you, that I could drive the same seven per cent. faster with the hind-wheels, than with the common wheels; the machinery giving out its power in one-third less time, while I am entitled if I choose to use wheels one-sixth larger than the common wheels, if it is not found that small wheels rapidly driven give the best results. I shall thus bring my driving surface fully up to that of the largest midship-wheels (the large seven-inch wheels before you making equal revolutions with the six-inch paddle-wheels), while yet I retain the great superiority of easy driving at the highest speed, or any speed whatever, because, as afore-shown, my hoof-shaped floats contain the pure and simple elements of propulsion, without resistance on entry or lift on exit. The common wheels lift more and more water the faster they revolve; my hind-wheels have no lift, and therefore they excel.†

3rdly. Hind-wheels give, of necessity, a very powerful steerage, because they send aft two columns of water, one upon each side of the rudder, which also meeting aft, destroy each others ripple, thus making tugs so fitted, peculiarly suitable for canal work. Worked with a pair of horizontal engines, each distinct from the other, but with a power of coupling them in long distances, no rudder will be absolutely needed, and hind-wheels will turn a vessel on its centre even better than do the twin-screws; while these last require a greater depth of water than do the hind-wheels.

4thly. They will enable us to use vessels of very light draught, instead of 20, 26, 22, 18 feet, they will enable the heaviest guns to be carried at 16, 12 feet, with buoyant, steady swiftness. In fact, all vessels will now be constructed to skim the waters rather than to plough

* At this stage of the lecture the action of the hind wheels, with wheels of 7 inch diameter, were shown in water.—J. S. P.

† H.M.S. ship "Salamis," October, 1863, could not use full boiler power to advantage with Morgan's feathering wheels, the vessel being found to go fastest with but half-power.—J. S. P.

deep; a great gain, indeed, for with increased beam, and a long fore-foot, and great swiftness, increased seaworthiness will be obtained, and that in many points, such as wear and tear, pitching, straining, tossing, and rolling, &c., on which it is not needful for me now to dwell.

5thly. The backing power for suddenly bringing up at speed will, I think, be found to be very good, and amply sufficient to back a ram off if required, which I doubt, after the delivery of an overwhelming stroke.

6thly. They give power to run upon an even keel to the diminishing of loss by friction, requiring even less draught of water than do the present highly approved twin-screws.

7th and lastly. They can be screened in a very considerable measure below the water line from side shots, by shields of double strength, for the breadth of the vessel between the wheels will give ample buoyancy to her stern, and while claiming a great superiority of speed and steerage, they can always drive a ship direct upon an enemy, so as only to expose the bows to glancing shots, a matter of imperative necessity, as the guns continue to triumph over armour-plates. Our present deep rams, driving between close jamming walls of water, will be able to inflict little or no damage upon a flying steamer, their speed being so little superior if at all, while to our grief, as Britons, we have to lament that rams will be formidable to sailing merchantmen, unless we can secure by means of hind-wheels, a vast superiority of speed for all our vessels. With rams of light draught and great speed, gunnery may be defied. The ship magnificently propelled will be its own self-contained projectile, the be-all and the end-all for itself and others. We shall "pursue our enemies and overtake them, and turn not again till we have consumed them."

Of the twin-screw system I will only further notice, what all will probably have observed, namely, the larger continuous driving surface of the hind-wheels, and their direct action as opposed to indirect.

In conclusion, I have to perform a certain duty, and to ask for your kind, your friendly consideration, if I may so speak, while I endeavour to discharge it. We all know that it is considered a mean thing for a man to borrow his ideas from other men's books, and after working them to his own purposes, bring them forth as if original, as if his own. Therefore, I have to render honour where alone it is due; and am as truly constrained by common honesty as I am by other feelings, to tell you that I obtained the propellers before you from the Bible, as if I had obtained them by reading in the book or books of man.

It were too long to narrate how I first got the idea of the shape of a calve's foot as a naval propeller; though strange possibly for me to say, and you to hear, I got it from the Bible. And with wheels like those before you, modelled from a calve's foot, I drove a boat (in the presence of three witnesses) 22 × 5 feet beam, with two pairs of wheels, the other pair being common wheels, and both pairs of 4 feet diameter—I say I drove this boat 300 feet in 41 seconds (5 miles an hour) with two young men working, as against

the performance by the common wheel of the same distances in 57·4 seconds—41″ to 57·4″— in one-third less time.

Having achieved thus much, I thought that it would gladly be taken up, and lost a whole year in trying to have it so done. But failing, I took up the idea of prolonging the calve's foot, to suit after or hind-wheels.

While protracting the same on paper, my attention was drawn to several passages in Scripture; one in the Second Book of Samuel, one in Micah, one in Habbakuk; but especially to the 33rd verse of the 18th Psalm, where, describing the making of war, it is written, "it is God that girdeth me with strength, and maketh my way perfect. He maketh my feet like hinds, and setteth me upon mine high places." While the passage in Micah reads, "Arise, and thresh, O daughter of Zion (by which I think Great Britain is meant) for I will make thy horn iron, and I will make thy hoofs brass, and thou shalt beat in pieces many people."

Accordingly, having made my drawing, I took it to the British Museum, and found that I had actually, without knowing it, drawn the shape of a hind's foot. And applying that shape as a propeller, I have found that the more correctly I worked out the hind's-foot shape, the better my wheel became.

The greater the speed at which they are driven, the more decidedly their power and action are developed, in contradistinction to all other paddle wheels; and the direct action and driving surface of these hind-wheels, place them at once beyond all competition by any screw or screws.

So then I have, in conclusion, three analogies in order; namely, mechanical aptitude, for as an engineer said to me, "by all the rules "of mechanics, your wheels ought to be a great success." Next, I have the analogy of the cormorant's foot, according to natural history. And, thirdly, I have that literalism of the word of "The Lord of Hosts," alas! too much neglected, or even derided in these days, but to myself, I must confess, a source of practical comfort, of instruction, and, I hope, unbounded confidence. And I do look forward, I confidently avow, to the time when every steamer that leaves our River Thames, that river of strength, will go smoothly flashing through its waters driven by hind-wheels, fitted with hind's feet, and "Walk the waters like a thing of life."

While for the present, conscious that my wheels, or at least my mode of placing and adapting them to the lines of a vessel, may admit of great improvement, I do rather hope to obtain some assistance towards that end from any comments which my statements may evoke.

Gentlemen, I have to thank you for the kindness with which you have listened to so humble an amateur as myself, and I beg to offer my best thanks to the President and to the Vice-President in particular of this evening, and to the members of this Royal Institution, for affording to me the opportunity of bringing this new form of paddle-wheels working under the counters before a discerning audience.

Dr. CROFT: If it may be permitted to make a remark as the inventor of what I call screw-paddles, I should like to know how Major Phillips overcomes the back lift? *If he is enabled to do that, I should be inclined to look upon his as a very valuable invention.

The CHAIRMAN: This would exhibit (pointing to the model in the water) whether there is any lift. Perhaps you will explain what you mean by your screw-paddles?

Dr. CROFT: I don't know whether I should be in order: if you will allow me to offer an explanation, I should be very happy to do so (producing a model).

Major PHILLIPS: I have put this pair of wheels, having straight-lined hoofs on for convenience sake. I shall be very happy indeed, if there is time to put this pair on (showing, as I consider it is a better pair); because, though the wheels are smaller, the hoofs have their angle lines curved.

The CHAIRMAN: I suppose, substantially, they are pretty much the same.

Major PHILLIPS: No, they are not quite, because of the difference in the angle lines; then again, the larger you make these wheels in reference to the dip, the less and less water they raise, and the better angle they go out at.

Dr. CROFT: I should like to see it on a larger scale, because we could then compare the results better.

Mr. BARRASS: This seems to be a very good thing; there is one point I should like to mention, the author seems to make a point in dividing the paddle into seven equal divisions, with a view of securing one float to enter the water at the same time as the float on the other side is rising.

Major PHILLIPS: I am thankful to Mr. Barrass, for putting this forward, because it will enable me to clear up the difficulty. When I said that under this system there was always one float just entering, one working and one just leaving, I see from what you say, that this needs explanation. It is not so; that is to say, it is not so when the vessel is perfectly at rest, and before the well is cleared out; and, therefore, it is not until the well is cleared out, that the hoofs get into their full action. But of course, with any power on, the well is immediately cleared out; and then the action goes on with one hoof just entering, one full in and one just leaving. When the well is cleared down to that point (showing the lowest point of the well) you have one coming in in vacuo all the way. This one (pointing to the second hoof below the water line) is in full work—has full grip upon the condensed water, which is coming up from underneath instead of working in water rushing through it, as the screw does; and the third hoof is just coming out. In the trial of the twin-screws, mentioned to-day in the *Times*, they made 300 revolutions and only ran six miles an hour. Seeing that the experiment was deemed a great success, I was perfectly astonished to find only that result of speed; but I am not at all astonished when I consider that screws have to wabble amid waters which are rushing through them.

Mr. BARRASS: With respect to the double screw, do you propose to make your propellers as efficient as the double screw for manœuvering purposes? Do you have one shaft?

Major PHILLIPS: No; I use them with separate shafts, but I give them an arrangement by which you make the two shafts into one for purposes of long voyages. I arrange them so that they can work just as the twin-screws do with independent engines.

Mr. BARRASS: I simply asked the question, because you did not name it in the paper.

Major PHILLIPS: I have a sketch here which shows that. It is a drawing for an Indian river boat, of a hundred tons, in which I have drawn in two separate engines.

The CHAIRMAN: I am sure we are very much indebted to Major Scott Phillips for the introduction of this subject to the meeting. I think that without doubt, it is a decided improvement. I have long thought myself of adapting some form of float that would enter the water without violence, and without a shock, and would not raise the water; that would be a very desirable thing. Of course we have seen that

* Dr Croft did not enter the lecture-room till after Major Phillips had shown that there could be no lift of backwater, as by Diagram Fig. I.

in screws there is a very considerable loss of power: you drive them at a great rate, and there is a great consumption of coal. You get a greater speed no doubt, and under certain circumstances a considerable advantage; but, taking it on the whole, there is a very great disadvantage arising out of the consumption of coal which is necessary, and when you come to head-winds, there is always a great consumption of coal without any corresponding result. I don't think that will occur here while under similar circumstances in smooth water. I think there would be a greater result. This plan has decided advantages over the side paddle-wheel, and it approximates more to the twin-screw. It is of course a question only to be determined by experiment, as to whether it will give greater results than the twin-screw. No doubt you can get a greater suface here, but all paddles have this one disadvantage, this, perhaps, less than any other, that they are immediately affected by the alterations of draught; that is to say, as you consume your coal, you lighten your vessel, and as you lighten the vessel you lessen the dip of your wheels, and the consequence is your engines run away with your wheels, and there is a loss of power. On the other hand, if you so adjust your paddle-wheels that they give the best results when they are very deep, they lose power accordingly as they get lighter, or *vice versâ*. If you arrange them so as to have the best effect when the vessel is light, you have to contend with the disadvantage of heavy draught. I think alterations in draught will not make very much difference with this plan. I think they will be nearly as effective with a deep draught as with light draught, which is just what occurs in the screw. It seems in the screw, that the deeper the vessel is, notwithstanding the greater weight, the greater is the effect, because you get it into more solid water,—so you will have here. I quite agree with what Major Phillips says with respect to the water coming up from below. Again I think that experiments with larger vessels will give greater results than those mentioned arising out of this fact, that the larger the vessel is, the greater is the column of water to press the water under the paddles. The more solid the water is, and the deeper the immersion of the wheels arising from the greater column of water, so the effect will be increased.

As we have another paper to read, I will not occupy any more time. Will you allow me to offer your thanks to Major Phillips for his very interesting paper? He has gone into quite a new field, and it does him more credit inasmuch as it is not his profession, and he has not had the advantage which many of us have had.

Major PHILLIPS: I beg to return my best thanks for your kind reception of my paper, and that, not only by all present, but by the members of the naval profession in particular.

MONT STORM'S SYSTEM OF BREECH-LOADING.

Contributed by Mr. F. A. BRAENDLIN, and read by CHARLES PHELPS, Esq.

GENTLEMEN,—At the request of several gentlemen much interested in the recent improvements of small arms, I am induced to come forward on the present occasion to state my views on the subject, which were acquired by theoretical and practical experiments.

All the recent improvements, particularly in breech-loading principles, depend in a great measure on mechanical laws; and I know of one breech-loader, devised and made by a mechanical engineer, which is in my opinion the best, and which will maintain its superiority over all other fire-arms.

Great attention has been given for some time to the study of the different kinds of small arms in use, to the improvements which have been effected lately, to the different projectiles, to the different modes of rifling, and so on, all of which must come into consideration when we speak of military small arms.

I do not think it necessary, and besides it would take up too much time, and perhaps tire the patience of the audience, to go into details regarding muzzle-loading fire-arms; besides, the estimation in which they were held is rapidly declining, and they will soon be one of the things of the past; and I am sure the generation to come will look with the greatest astonishment at a weapon where a stick called a ramrod was necessary to push the charge down into the barrel, when it is so easy to load at the breech. Muzzle-loaders, however, are still used, and every one present is no doubt acquainted with the weapon in use in the English army, I mean the Enfield rifle. Now I have no doubt it will be admitted by all using muzzle-loaders, that loading is a dangerous operation. I, for instance, always feel nervous when pushing the charge down the same road by which it has to come out. The Enfield rifle is an excellent weapon, and at the time of its introduction it was no doubt the best then in existence, but such important improvements have lately been made in fire-arms that it has been decided, I believe to the best of my knowledge, to exchange by degrees the present fire-arm for one more serviceable, and capable of greater execution. To select such an arm it is of importance to consider two things, first, is the new arm to be again a muzzle-loader or a breech-loader.

I am sure every one will agree with me that if we can get a breech-loader that fulfils all the conditions required of a serviceable arm, let it be the one by all means; but to satisfy even the advocates (if there be such) of muzzle-loaders, let us inquire whether there is an arm which is both a perfect muzzle-loader and breech-loader at the same time. If such an arm can be found, decidedly that is the arm which we want, and which will satisfy everybody.

But in the selection of such an arm, it is again important to consider which is the simplest, safest, and cheapest arm of this kind.

The variety of breech-loaders is becoming endless, but all, with the exception of one, fail in the first condition, viz., that there must be no escape of gas, to prevent which almost all require the use of a greased wad, which will never do for a soldier. The reason of this defect is, that in all those breech-loaders, the force of the explosion has a tendency to separate the joint, whilst what is wanted is one in which the force of the explosion *shall close* the joint, and in which the greater the charge, the more effectually shall the joint be closed.

Special ammunition is also very objectionable, for if the special ammunition should be wanting, the arm would be worse than useless. We want a breech-loader which can be loaded with loose powder and ball at the breech if there is no ramrod, or at the muzzle, if there is one, and we choose to do so.

To load with loose powder and ball we must have a solid breech on a solid recoil, and I know only of one which has those desirable pro-

perties. A military arm of this kind must likewise be simple, and must have no delicate parts that require nursing, or it will not do for a soldier. Safety is another great consideration. A breech-loader that cannot be discharged before everything is safe and in its place, and which can be placed without risk in the hands of any raw recruit, is no doubt what is wanted.

Now we come to a very important point, particularly for the country at large, I mean the pockets of the taxpayers. There is no doubt about that, for economy is a very important point.

Now if we can find a breech-loader which is almost as cheap as a muzzle-loader, a great point would be gained; but if we could find a breech-loading principle which could be applied to the existing arms at a nominal cost, that would be best of all. Again, I say there is only one I know of which has all these properties, and I have it here; I am sure it will be interesting to all, for it may be the future arm for warfare, invented and patented by Mr. Mont Storm.

I said before, three points have to be considered, viz.:

First—Simplicity
Second—Safety
Third—Economy.

Let us examine Storm's breech-loading rifle. Is it simple? Most decidedly it is. You have but to open the breech, put the charge in, close it, cap it, and your gun is ready for firing. There are no levers, latches, and all those niceities required to work it, which form an essential part in all other breech-loaders.

In order to give you an idea of its extreme *simplicity*, let us look at its construction. If we take for instance a regular Enfield barrel, cut a piece, say two inches, off the breech end, connect this piece by a hinge with the barrel, so that the breech can be opened and laid on the top of the barrel, fit into this breech-piece a steel tube or valve, which in closing inserts itself into the barrel recessed for the purpose, and which entirely prevents the escape of gas, being in fact the continuation of the barrel, called a valve, gas check, or expanding ring, and of which I shall have occasion to speak more fully presently, and we have a breech-loader of the simplest kind, so simple, in fact, that General Guiod, who made official trials of these guns in France, says in his report to the Emperor:

"That these arms are of a solidity and simplicity, of which no other "arms of this kind can give an idea." And again, in another place he says—

"These breech-loaders fulfil all the conditions required of a perfect "military arm."

It will be observed that the breech A (Plate XX, Figs. 2, 3) is solid, as solid as that of any muzzle-loader; at the back of it is a little recess B, Fig. 3, for the purpose of locking the breech secure in its place. Of this point I shall have to speak when we come to the second head, namely, safety.

But before doing this, I must ask your attention once more to this very ingenious contrivance, called the valve or expanding ring, C, Figs. 2, 3, and it will be seen that no breech-loader can be perfectly gas-tight

WESTLEY RICHARD

Fig. 4.

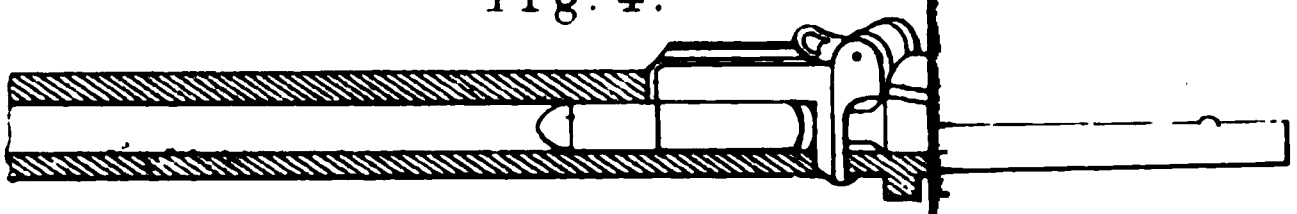
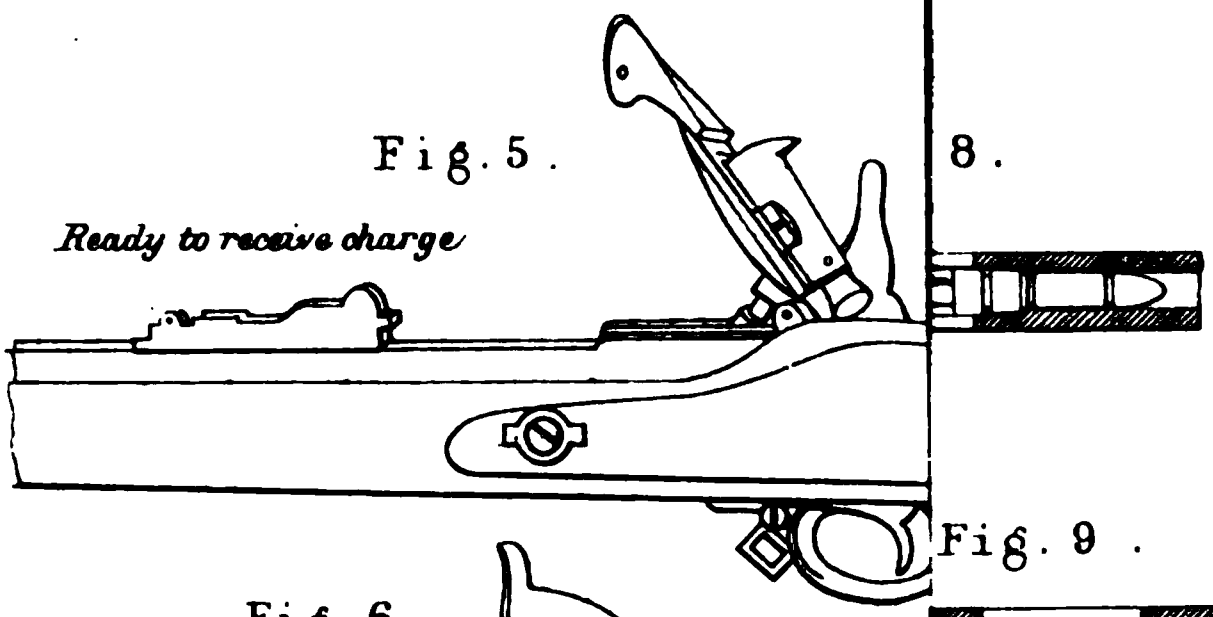


Fig. 5.

Ready to receive charge



8.

Fig. 9.

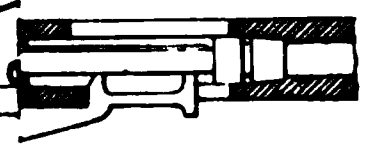
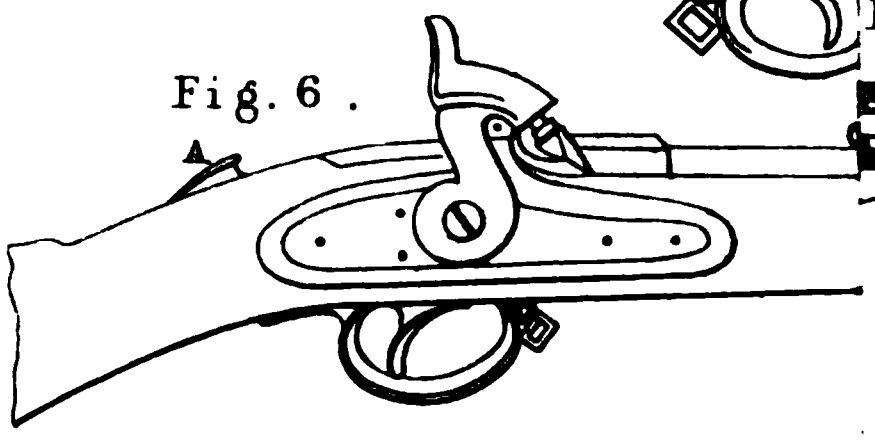


Fig. 6.



MONT STORM'S

Fig. 1.

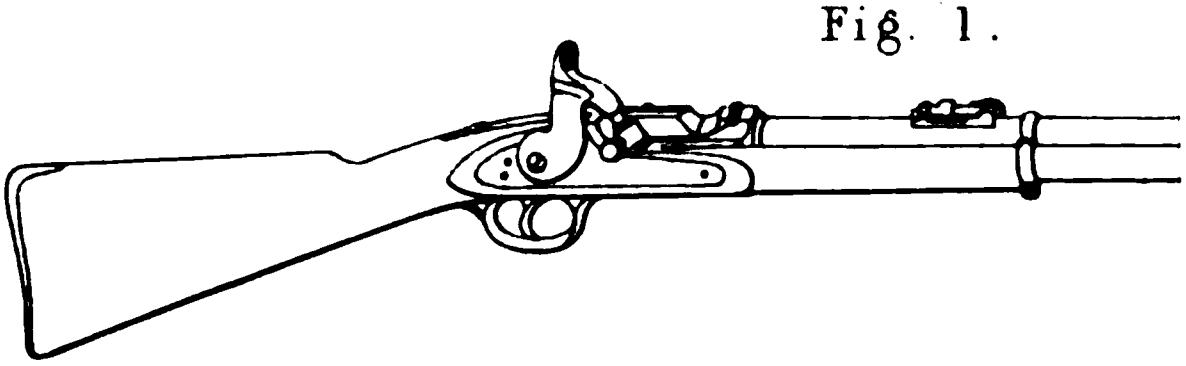
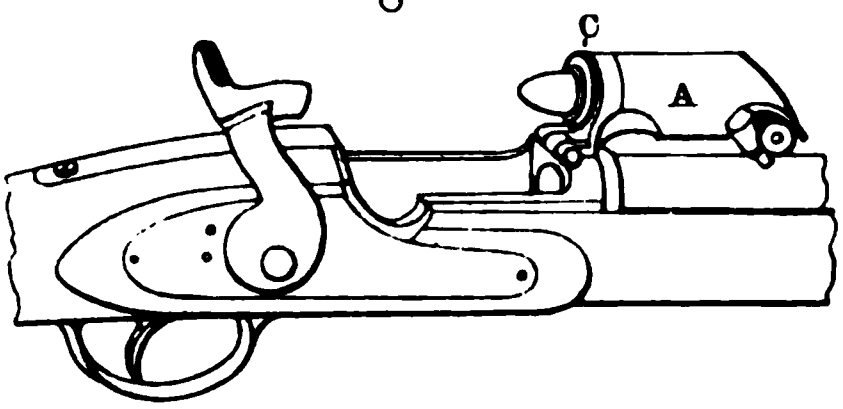
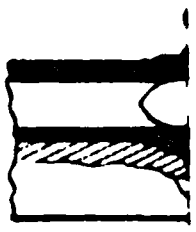
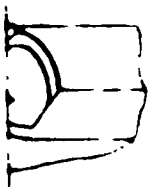


Fig. 2.







J.R.Jobbins.

without it. If you look at this little ring you will find that it is at the back tapered down so as to present a surface to the explosive force. Now it is natural that this ring or valve at the discharge will be pressed forward into the barrel, and at the same time expand so as to prevent any escape of gas. So perfect is this contrivance, that at the late meeting at Wimbledon,* such rifles have been fired as many as 400 times in succession, and yet not the slightest escape of gas was perceptible.

It will also be observed as quite natural, that by an increased charge of powder, the ring will, with increased force be pressed against the face of the barrel, in contrast to any other breech-loader in existence. Every one must agree with me that it is the simplest contrivance to get a good and efficient breech-loader.

Speaking of simplicity, I should just like to mention a little circumstance, which was commented upon by many gentlemen, and particularly by some of the Birmingham gun-makers, that is, that the breech fits *so loosely;* and they attribute that no doubt to bad workmanship. Now every gentleman present will know by experience, that all things expand when heated, especially metals. After firing twenty or thirty rounds in rapid succession, breech-loaders that have to fit with mathematical nicety to prevent escape of gas, will stick fast and become useless. Not so with Storm's breech-loader; allowance is made for this circumstance, without depriving the gun of any of the conditions required in a good breech-loader, and therefore the gun can be fired any number of rounds, without any impediment being felt. This is an answer to such futile objections.

The second point, viz., *safety*, is self-evident if we look at the contrivance for locking and securing the breech, B, Fig. 3; it will be seen that the gun cannot possibly be fired without everything being secure in its place, as the hammer could not by any means reach the nipple and explode the cap, and it is altogether impossible to have an accident, and may therefore be given into the hands of raw recruits, as I said before, without the slightest danger.

We now come to the last point, *economy*. Practical men will understand this point better. There is no gun extant, muzzle or breech-loader, that can be turned out so cheap with proper machinery.

Storm's breech-loader can be made cheaper and better than any other gun.

Storm's gun can also be made stronger, and at the same time to look more graceful. Storm's gun can be made to shoot equal to, if not better, than any muzzle-loader. I, for my part, am sure that it will shoot better than any muzzle-loader that can be produced.

Now, if an arm can be made that combines in itself a perfect muzzle-loader, as well as breech-loader in one, that is stronger and more serviceable, and does not require nursing and careful handling; that will shoot equal to, if not better, than any other arm of whatever make or name, that will wear long and stand much use, that is simpler than, and as cheap as any other arm, it is natural that we must call it

* Not the meetings in July, 1864, but in 1863.—Ed.

the most perfect arm of the age. I have said that it is the cheapest arm; I will go a step further, and show that it is an efficient breech-loader, that it is A 1 in every respect; that it is a muzzle-loader at the same time, that it is in fact so good and perfect that no other arm in existence can equal it, can be got that combines two points, simplicity and safety, and can be produced at a small outlay by converting the present Enfield.

I call it economy, as it would save the country millions of money. The present Enfield can be converted or altered into a breech-loader on Mont Storm's principle.

The converted rifle will still be a muzzle-loader, if required; it will be a breech-loader that can be loaded with entire or special ammunition, with the Government ammunition at present in use, or with loose powder and ball at the breech, or at the muzzle of the barrel; in either way it will shoot equally well.

If you consider the terrible execution such an arm is capable of doing, that it can be discharged six or eight times, in case of necessity, in a minute with accuracy; that this arm can be loaded and fired in any position, with entire or breech-loading ammunition, or with loose powder and ball, it must be self-evident that an army with such weapons, is more than three times a match for an army armed with common muzzle-loaders.

Mont Storm's system of breech-loading is applicable to all arms, from the pea rifle, to the largest bore or elephant gun, to the punt gun and field artillery, to 3-pounders and up to 18-pounders.

The jury in the great International Exhibition of 1862 appreciated the merits of these weapons, by awarding it a prize medal, mentioning particularly the merit of its being capable of being applied to the conversion of the Enfield rifle. No one that is at all acquainted with the leading newspapers can have omitted reading in what a spirited manner this subject has been taken up by all and every one, particularly by the *Times*, *Army and Navy Gazette*, *Volunteer Gazette*, &c. Captain Sherard Osborn, an able officer, has shown his appreciation of the principle, by arming the best marksmen belonging to the Anglo-Chinese expedition under his command entirely with this weapon.

A few extracts from some of the leading papers will not be out of place here:—

Times, 13*th July*, 1861.

During yesterday and the day before, Storm's breech-loading rifle was exhibited on the ground (Wimbledon). A description of this *most perfect of all breech-loaders* has already appeared in our columns, and *its immeasurable superiority* over all other weapons of the same kind is so well known now, that further praise is needless.

Times, 15*th July*, 1862.

Mr. Storm's American breech-loader, to which we ventured to direct attention, as being *beyond all doubt* the best breech-loading rifle in the building, has met with the cordial approbation of the jury, who have awarded it a prize-medal, &c.

Times, 31*st July*, 1862.

The American breech-loading rifle is now, since it gained the prize-medal, left out in the Military Court for public examination. The interest which this weapon

is exciting among military visitors, foreigners as well as English, is very great, and seems to be getting greater every day. In the Military Court, the breech apparatus is shown fitted to the Enfield, Whitworth, cavalry, and other rifles, and its *incontestable superiority* over the European inventions of the same kind can be seen the instant the weapons are compared with English, French, or German breech-loaders, &c.

Volunteer Service Gazette, 25th July, 1863.

Just before the conclusion of the meeting a very interesting shooting took place under somewhat novel conditions. The patentees of Mont Storm's rifles had not only a tent on the ground for the display of their invention, but had very wisely given two prizes to be contested for by rifles fitted with their breech—for their invention consists simply in fitting a breech-chamber into any rifle, and thereby converting it from a muzzle-loader into a breech-loader. The principle is an exceedingly simple one; and the patentees have particularly directed their attention to the Enfield rifles, both long and short, so that the Government at a small expense might convert the national weapon at once from a muzzle-loader to a breech-loader. The conditions of the prize were very properly framed, so as to show the great advantage of the breech-loader in quickness of fire, while nothing was sacrificed in precision. Each competitor was accordingly given the use of the butt for two minutes, and he was supplied with a Mont Storm rifle and plenty of ammunition, with which he was at liberty to load and fire as fast as he pleased. There were two prizes to be given to the highest and next highest scores thus obtained. There were upwards of forty competitors, and the first prize was won by Ensign Starkie, of the Queen's (Westminster), who made 34 marks in 11 rounds. The second prize was won by Serjeant Drane, of the London Rifle Brigade, who made 32 marks in 13 rounds. One gentleman fired as many as 15 rounds in the time allotted, while another fired as few as 8. All fired from a sitting or lying down position, and the advantage of loading a breech-loader was seen in a moment, when compared with the intolerably awkward military position of loading a long Enfield muzzle-loader from the knee. The rifleman with the breech-loader need never rise from his lying-down position, and consequently need never expose himself in the least to an enemy's shot—an enormous advantage in skirmishing and outlying or ambuscade work. We are glad to hear that the patentees are organizing a company to bring their invention into general use; and so sure are we that the breech-loader must ere long supersede the muzzle-loader, that we gladly welcome any effort in this direction, and more particularly one that is, as in this case, so closely connected with the national arm. We have watched this rifle with some interest, as it was brought under our notice nearly twelve months ago. We tried it through all the ranges up to 1,000 yards. At that time the inventors had not quite determined on their cartridge, and we used some skin cartridges that were not quite satisfactory. The rifles may now be loaded either with Government ammunition, with an improved skin cartridge, or from the flask, and their shooting at Wimbledon showed the merits of the invention in a very strong light.

No one could have witnessed this contest without contrasting it most favourably with the small-bore shooting of the meeting. The latter, it is true, was carried to the extremest verge of excellence, and bull's-eyes at 1,000 yards were made over and over again: and yet the small-bore has done nothing, literally nothing, in advancing the military defence of the country, and we very much doubt if it ever will advance it. Its very success is, in fact, harking on the leading hounds on a false scent. This Mont Storm contest—almost unobserved, and known but to few who attended the meeting, as it was—on the other hand, is all in the right direction. It showed the military qualities of a rifle in the highest degree—great simplicity, great quickness, great precision; and, man for man, a section of breech-loader riflemen would give an account of a section of small-bore gentlemen before the latter had unpacked their apparatus and got their rifles into working gear.

The following scores were made with

STORM'S BREECH-LOADER.

	Points.	No. of shots.
Ensign Starkie, Queen's (winner)	34	11
J. Drane, London Rifle Brigade	32	13

I will here also subjoin the description of Mont Storm's breech-loading fire-arms in his own words.

Breech-loading arms may be divided into twelve different systems or "species," and there are at least eleven "varieties" of these species. The twelfth species (Mont Storm's "self-sealing chamber system") is of comparatively recent development, and its plan is adapted so as to be universally applicable to every style and class both of military and sporting arms, or the ready conversion of present muzzle-loading arms into breech-loaders. Some of its many points of merit may be enumerated as follows:—

It has a chamber, but no lever, either lateral, vertical, or of any other description, to catch in the accoutrements, dress, or bridle-rein.

It is confined to no special ammunition.

The charge may be varied, but the arm cannot be overloaded.

The explosion takes place within a solid chamber. The recoil is upon a solid breech.

The connection between the stock and barrel is strong, graceful, and "fixed:" thus it is adapted for the use of the bayonet for infantry.

The opening and closing of the chamber is effected with unprecedented ease and rapidity by means of the mere finger and thumb, even when the weapon and the soldier are lying upon the ground, and, in the case of cavalry in action, the left hand remains entirely free to govern the reins. It is a perfect muzzle-loader. The force of the explosion—irrespective of special ammunition—closes the joint, in contrast to its effect in other breech-loading arms; thus there is no escape of gas.

It cannot stick fast or clog by rust or powder dirt.

There is no sliding or abrasion of one surface upon another in opening and closing the breech, so there is no wear by friction.

In the insertion of the cartridge, the ball constitutes the handle or ramrod—an important feature.

It cannot be fired accidentally or purposely till the chamber is locked in place; and the locking device is solid, "self-acting," and infallible in its operation.

It is extremely simple, involves no delicate parts, and cannot easily get out of order.

There are no specialties of lock, stock, barrel, or mountings: thus there are no mysteries in its repair: it is of economical construction, and an approved species of "self-acting primer" may be applied to it.

These arms may be thoroughly and quickly cleaned without the application of water.

Though these arms are only now about to be brought before the public in this country, they have received greater approbation at numerous public trials before Governmental and military authorities in America than any arm hitherto known.

WM. MONT STORM, N.Y.

3, ROOD LANE,
January 1, 1863.

Mr. PHELPS: This is the valve (opening). The explosion taking place in the chamber drives everything before it, and so doing, the lips of the valve are taken against the lips of the barrel preventing the escape there would otherwise be of the gas. It is a solid breech,—it is merely the end of the barrel cut off or another substituted for it. It is solid, just the same as if it was a muzzle-loader, and the recoil is on the solid base of the gun.

The CHAIRMAN: How is it closed at the joint where the hinge is?

Mr. PHELPS: The breech-piece is merely attached by the hinge to the barrel. The gas is prevented escaping by the valve fitting into the end of the barrel.

The CHAIRMAN: Is there a double valve?

Mr. PHELPS: There is only one valve.

The CHAIRMAN: Is there a straight vent into the chamber?

Mr. PHELPS: An angular one.

The CHAIRMAN: There is objection to that angle.

General BOILEAU, R.E., F.R.S.: I wish to make a few remarks on the principle of this rifle. If you will allow me, I will take it into my hands and explain my remarks. It is, Mr. Chairman, a matter of paramount importance that we should consider all the circumstances connected with every invention which is brought forward in this theatre, because I believe that Government look greatly to the discussions which take place here, for opinions which they probably would not receive otherwise; and on that ground I think we ought not to allow the points which have been brought before us this evening to pass without the expression of some opinion as to the quality of gun which is submitted, and also as to its comparison with other breech-loading guns which have been brought under Government notice, and some of which are introduced into the army. Without any wish to refer personally to the inventor of this very beautiful and highly-finished piece, I may say a few words on the principle involved in its construction, because it is on that only I wish to speak. To commence with the principle: I may say that it is acknowledged that curvilinear motion, which is to be resolved into rectilinear motion, is not the principle which you should have where the object is to bring two surfaces into contact the one with the other. It is desirable that the motion should be in a straight line, and therefore I think that all hinge breeches of this description, which turn over for the purpose of loading, and which are obliged to be turned back for the purpose of closing the two surfaces to be brought into contact, is not a correct principle. I have a great objection to the manner in which this gun is loaded. The gentleman who read the paper says he loads by the muzzle always with great fear. I have fired many thousand rounds from muzzle-loading rifles, and I do so with the most perfect certainty that there is no danger at all in the operation. In fact, I feel that I can load a gun from the muzzle with very much more security than I can load this gun from the breech; because in putting the cartridge in, I counter-march the breech before I begin, and then put the powder and bullet in in the reverse order in which they are to go out. That is, I place the bullet towards my own body, instead of towards the proper object to be fired at. Then as to the method in which the breech is closed, I don't think there is a perfect contact between the two surfaces, because from the explosion of the powder, if there is a valve which is supposed to close the breech, it must to a certain extent jamb, and in lifting up the breech in this way, there would be a friction upon the lower part and a scraping upon the upper part, which would in a short time, according to my apprehension, bring about a leakage of gas. Then in respect to the power which this gun is said to possess, of being loaded from any position, supposing it is required to load it with loose powder by the breech, how is this to be done when in such a position as this—kneeling or lying down? It can only be loaded with special cartridges from the breech, or Government, or other similar cartridges from the muzzle. I will now notice several forms of breech-loaders on the principle of direct action, all of which have their advocates, and are deserving of a separate description. Westley Richards's breech-loader (exhibiting one), see Plate XX, figs. 4, 5, 6, has a lift piece which carries a piston; the piston has at its fore end a gun metal or a copper plug, and at the rear end has a sloping shoulder, working against a stud. The cartridge is introduced bullet foremost, as I believe it is the only way it would be introduced by a soldier. The breech-piece is turned down, the piston works against the stud at the end of the chamber, and when the breech-piece is brought down home, the metal plug is pressed firmly into the barrel, and the gun is thus made perfectly gas-tight. Many thousand rounds have been fired out of Westley Richards's breech-loaders, and they have remained to the last as efficient as when first used. I believe a number of them have been introduced into the army, and I am informed they have given great satisfaction.

Another form of breech-loader is that of Calisher and Terry, figs. 7, 8, 9, 10. This (exhibiting the rifle) has also a direct acting piston. There is a side lever which moves on a hinge. This I consider to be its great objection. The side lever is

detached in this way (moving it). The piston is turned round, withdrawn, and the cartridge is put in, bullet foremost. The piston is then returned, the lever carried back, shut, and the piece is ready to fire. This, as far as the principle of action goes, has this objection, that when the plug is forced home, there is no play; it comes in contact with the solid end of the barrel, and, therefore, when the fore portion of the piston wears, the gas escapes, and the side lever is liable to be blown out. That I consider to be an objection to this principle, which has possibly acted to some extent in not securing for it that favour which the other portions of the invention entitle it to.

The last design I would bring to your notice is a form of breech-loader with which I have myself had something to do, and therefore it is a great pet of my own. It is the invention of Mr. Green (figs. 11—16), a gentleman of great mechanical ability, with a fair amount of practical experience, and the result appears to me to do great credit to his inventive talent and mechanical skill. It consists of a piston also, at the end of which a lever is fixed. The lever is raised in this way (working it), and the breech-piece withdrawn. The cartridge is put in bullet foremost, the breech-piece is pushed forward, the lever put down, and the piece is ready for action. Now there is one part of this design which secures the same ends that Mont Storm does, and that is a great advantage in both of these designs, namely, that until you have completed your arrangements for closing the breech, you cannot fire the piece. At the under surface of the piston there is a hole which has to be brought vertically over a pin before the gun can be fired. If you leave the lever in any position where the hole is not over the pin, you cannot fire the piece; but when you put the lever quite down, and the hole is brought over the pin, the piece may then be fired, so that it is perfectly secure. Then this rifle has an advantage which I do not see in other breech-loading small arms, namely, that you can detach your piston altogether, and throw it away, if you like, which under some circumstances is a great advantage. I dare say many of my hearers remember when the gunmakers of London received an order from the Government to take all the locks off the muskets that they had in store, fearful that they would be made use of for improper purposes during riots. So in India, if we had had breech-loading guns from which we could have removed the pistons, we should have taken away a very great amount of the advantage which the mutineers derived from the possession of Government small arms. This breech-loader of Mr. Green's has that advantage. By pushing the trigger forward you can take the breech-piece out, and destroy or throw it away, when, if your enemy gets possession of the rifle, it is useless to him as a fire-arm. These are points in which I consider Mr. Green's breech-loader has great advantages. Such is the description of Mr. Green's patent breech-loader; and without in any way wishing to speak of individuals, I think the advantages are decidedly in favour of this design. Government have, I am told, viewed it favourably, and Mr. Green is fitting his breech-loading apparatus to different descriptions of Government small arms for trial. I have seen one of these guns which fired 1,000 rounds, 700 from the breech, and 300 from the muzzle, almost without a perception of the effect of smoke in the breech chamber. I have myself fired with them when they were in a more imperfect state than they are now, many rounds from the rest, from the shoulder, and from the knee, and I have found their action easy and certain, and the escape of gas imperceptible. There is another point which I consider to be a very great improvement on all other methods of closing the chambers that I have seen. The fore end of the piston consists of a disc fixed on an axis, working on the piston against another disc fixed to the end of the piston or plug, and interposed between the two is a wad of vulcanised india-rubber. There is a slight slot motion for the fore disc axis, so that when the powder explodes it presses backwards upon the vulcanised india-rubber wad between the two discs, and most perfectly and completely prevents the escape of any gas. When the gun is used as a muzzle-loader, a wad of vulcanised india-rubber, rather tight for the barrel, is first passed down, and with that wad several hundred rounds have been fired from the muzzle without more than a discoloration of the surface of the wad. I think if any breech-loading piece is to be generally introduced into our army, and I am not one of those who think breech-loaders will altogether supersede muzzle-loaders, at all events, for some time yet to come, Mr. Green's breech-loader, manufactured by Reilly, ought to command the attention

of Government, as it will, I firmly believe, have the approbation of all men interested in improving the weapons which are placed in our soldiers' hands.

Captain RADCLIFFE, R.N.: I wish to observe that I do not think Mont Storm can claim any novelty in his gun; for four or five years ago, I brought forward the same system. I took it to Mr. Wilkinson, and he told me, "It is a very good thing, but you cannot do anything with it, because the bolt is Leech's Patent." How Mr. Mont Storm has got over that I do not know. I thought it was then of no use my doing anything with it.

The CHAIRMAN: When you say the bolt, you allude to the hinge?

Captain RADCLIFFE: The bolt which secures it in the breech. This other part was invented by Captain Palliser, of the 18th Hussars. I took no more notice of it at the time, and should not have done, till some time since, I saw Mont Storm's gun, and looking at it, I saw it was exactly the same thing except in the valve, which I do not attach so much importance to, because, if you look at this (exhibiting a rifle), you will see, by having a soft metal ring which would expand with the heat when fired, it would stop all escape of gas. If you look at it, you will see it is exactly the same principle as Mont Storm's.

The CHAIRMAN: Do you invert your cartridge?

Captain RADCLIFFE: No. I am not going to bring this subject forward, as I did not anticipate anything would arise. This rifle was made four or five years ago. If you will look at it, you will see it is as similar as possible to Mont Storm's, except that my bolt is at the side. It is the same principle. One great objection is, that if the nipple were worn, the hole would be very large, and it would throw the hammer back, and then the thing would get out of order. Another objection is, that in loading, the powder gets into the bed under the breech, and when you put it down you cannot shut it. This might be obviated by cutting a piece out of the bed to allow the powder to force through. I merely mention it to show that Mr. Mont Storm cannot claim the invention, for I have had this five years.

Mr. BETHEL BURTON: The gentleman who has favoured the meeting by reading the paper has endeavoured to impress upon us the superiority of his system. I have the pleasure of laying before this meeting a breech-loading gun of my invention, and am content to submit it to the judgment of the many gentlemen of known ability I see present, that they may form their own conclusions, first giving an explanation of the arm before them. It is made from an Enfield rifle, adapting the materials at present used for its construction, so that rifles already in use can be altered, according to this system, at a trifling expense. The great difficulty attending breech-loaders is, that they are found, after a little use, to allow an escape of gas at the joints, and every conceivable plan has been resorted to to prevent this evil. It is pretty generally admitted, that if the joint can be effectually closed, and a strong serviceable gun produced, the breech-loader would supersede the present muzzle-loader. I hold in my hand a gun in which no mathematically-fitting joint is required in order to prevent an escape of gas, and, consequently, there is no joint to wear out. The gun is strong and very simple. There is only one screw used for the purpose of keeping the breech-piece together, and it may be withdrawn for the purpose of cleaning, leaving the barrel open from end to end. The means employed to prevent the escape of gas consists of a copper case or cartridge, made without seam, containing the powder and bullet, and in the base, the fulminate, which is ignited by a blow. This cartridge is the most perfect of its kind. It is perfectly air and water-tight, so that the rifle may be fired during heavy rain, or after the cartridge has been immersed in water for hours. It cannot be ignited save by the means now employed, or similar mechanical means; it cannot be ignited by a spark or a flash from the fire of a gun, as is the case with the paper cartridges now used. It is also cheaper than the paper cartridge at first cost, and can be refilled as often as desired. Under the present system, in time of war when extensive guard and picket duty is necessary, the soldiers coming off duty are obliged to discharge their guns, involving the loss of the cartridges, besides the labour of cleaning the guns. With this cartridge, that is entirely obviated, as it may be withdrawn at pleasure by opening the breech, the gun of itself ejecting the cartridge, which is saved for future use. I calculate that this saving alone will pay for the extra cost of the new arm. There is no nipple to clog up or split, and no

cap to put on, which operation is rather difficult to perform in cold weather or on horseback, or in the hurry and excitement of battle. This advantage will enable the soldier to defend himself against superior numbers, as the rifle can be fired twelve times a minute, as readily as the muzzle-loader can fire three shots, and it is not at all affected by rapid firing. In case of necessity, it can be loaded by the muzzle with the ordinary cartridge, or with loose powder and cap, quite as effectually as the Enfield or other weapons. The breech works without fouling, and it may be fired 1,000 rounds or more, as long as the barrel remains clean; and, if the barrel could be kept clean, the breech would fire 10,000 rounds without requiring cleaning. In conclusion, I will say that if Mr. Mont Storm considers the challenge he has thrown out as a *bonâ fide* challenge, I am ready to accept it, and to enter the lists at any stated period, competing with him for rapidity of firing, accuracy, penetration, and freedom from gas escape, and also to shoot the greatest number of rounds. I am anxious to try my rifle against any gun, either in England or America, and will leave it to any disinterested military man to decide which is the better gun for military purposes, such referee to be named by Her Majesty's Secretary for War.

Mr. Byrne: I am acquainted with Mr. Mont Storm, and I should be very sorry to say anything against his gun in his absence. As to the ammunition Mr. Burton has spoken of, they can make these cartridges in the United States for less then a cent a piece,—ball, powder, fulminate, and all at the rate of 300 a minute. That cartridge is made cheaper than the paper cartridges made by Government here. The cartridge can be put in water for twelve hours; you can take it out of the water and it is immediately ready for use; you can throw them against a wall, you may sit upon them, you may throw a bomb shell among a house full of them and they will never explode. They never explode without the proper application of the hammer. Indeed, I may say all breech-loading guns are practically useless without that particular sort of cartridge. That is the cartridge now used in the terrible war now waging in the United States.

The Chairman: That cartridge would not do for Mont Storm's rifle.

Mr. Byrne: I think this is well worthy the attention of military men: I have tried all the various breech-loading guns made; in fact, I had folly enough to buy a good many of them, and at last I got one of these guns of Mr. Burton's. I fired 10,000 rounds out of it, and it is now as perfect and as clean as when I began. By making the bullet of lead having a composition of certain other metals, it never leads the barrel; that I think is a great point. There is no residue remaining, and if any one will take one of these guns to a United States officer, he is bound to have that particular sort of shot.

Mr. Braendlin: It would take me as long to explain Storm's breech-loader as to explain the other guns. The other breech guns exhibited here this evening look something like gas-pipes, they are not natural looking guns, none of them can be fired with loose powder. If I am out in the colonies and have none of that particular ammunition, if I cannot make up a cartridge, the gun cannot be loaded and is useless. I can load Mont Storm's breech-loader in any way I please. If you were to take Westley Richards or any other breech-loader, and load it from the muzzle, driving the ramrod down you would destroy the gun. You would destroy Mr. Green's in that way.

The Chairman: Mr. Green's may be loaded from the muzzle.

Mr. Burton: So does mine.

Mr. Braendlin: You can fire only one or two rounds.

General Boileau: I have fired seventy or eighty rounds in succession. If any gentleman doubts that Mr. Green's gun can be loaded from the muzzle, I shall be happy to fire 100 rounds in his presence any day.

Mr. Braendlin: With Mont Storm's gun I can use the Government ammunition and powder from the flask. Ten thousand rounds might be fired from it, which is more than can be done with any other breech-loader. An observation has been made about the abrasion of the surfaces. If you look carefully at Mont Storm's gun, you will find there is not the slightest friction in any portion of it. The valve re-inserts itself in the barrel, fits perfectly, and the breech is perfectly placed. It is the only rifle where everything is perfectly loose and can be worked without any friction.

I have fired Westley Richards' breech-loader, and have seen attempts made to fire it with loose powder, when on one occasion it burnt a gentleman's eye away. Had I known these other guns were to be introduced, I would have brought several specimens of Mont Storm's gun with me and would have explained them. This gun can be loaded from a powder flask when the soldier is lying down.

General BOILEAU: But you do not give a soldier a powder flask.

Mr. BRAENDLIN: In case of necessity.

General BOILEAU: Never, now.

Mr. BRAENDLIN: If I can load either way, it is certainly better than if I can only load one way: you will admit this. I have shown that I can load from the muzzle, I can load with loose powder, and I can fire with special ammunition. I do not think there is one breech-loader that would do what Mont Storm's did last year at the Wimbledon meeting.

General BOILEAU: I dare say there will be a competition this year.

Mr. BRAENDLIN: Yes, I dare say there will, because Mont Storm will give a very great prize and will see whose breech-loader is the best. This point will be settled. I think all breech-loaders that require special ammunition, or ammunition with fulminate in them are worthless.

Mr. BYRNE: Will you give us the reason why they are worthless?

Mr. BRAENDLIN: Because they are dangerous.

Mr. BYRNE: That is no reason.

Mr. BRAENDLIN: That is a very good reason.

Mr. BYRNE: Boiling water is dangerous.

The CHAIRMAN: We are very much obliged to you for bringing this subject forward, but I think you are a little under misapprehension; you know in all these discussions our object is to find fault, and if we can find fault with a thing best by bringing another into contrast, that is the right way. We are here as censors, and our business is to find the weak points, and it is for the inventor to strengthen those points if he can. I do not think there can be anything really progressive or satisfactory, unless that mode is adopted. There is no doubt Mont Storm's gun has considerable merit over many others; but I think as General Boileau has shown, that the language of depreciation used was rather strong, inasmuch as the assertions were not supported by proofs, but we are much obliged to you for bringing this subject forward, and I am sure those discussions cannot but tend to good. You have heard the comment made upon your rifle, and it will enable you to correct some of its defects.

DESCRIPTION OF BREECH-LOADERS ON PLATE XX.

MONT-STORM'S.

Fig. 1, side elevation of Enfield rifle fitted with Mont Storm's breech-loading chamber.
Fig. 2, breech raised, showing cartridge in chamber.
Fig. 3, side view, partly in section, showing position of breech at the moment of firing.

WESTLEY RICHARDS'.

Fig. 4 represents cartridge inserted and breech closed.
Fig. 5 shows breech open to receive cartridge.
Fig. 6, appearance of rifle, with breech closed.

TERRY'S.

Fig. 7, side elevation of musket, with breech apparatus.
Fig. 8, breech apparatus, with cartridge inserted in barrel.
Fig. 9, breech apparatus detached, closed up to breech.
Fig. 10, enlarged view of breech apparatus.

GREEN'S.

Fig. 11, side view partly in section, showing breech apparatus.
Fig. 12, piston or bolt, and the cover of the breech chamber.
Fig. 13, transverse section of the cover of the breech chamber and piston, or bolt.
Fig. 14, end view of ditto.
Fig. 15, breech-plug loose in breech plate, which partly turns round in plate.
Fig. 16, side view, with breech closed, and ready for capping.

LECTURE.

Friday, April 29th, 1864.

LIEUTENANT-GENERAL P. SPENCER STANHOPE, in the Chair.

THE PROGRESSIVE AND POSSIBLE DEVELOPMENT OF INFANTRY DRILL AND MANŒUVRES.

By Major TALBOT HARVEY, 1st Middlesex Eng. Vols., formerly Austrian Service and Suffolk Mil. Art.

IT may be said that the claims which modern times can justly lay to persons devoted to the cultivation of every branch of human knowledge, are in direct proportion to the degrees of perfection to which the sciences themselves have respectively attained; the most striking proofs of which assertion are to be found among those who now pursue the military career.

The only way in which one can account for the want of attention or improvement that drill and manœuvre has met with is, "that it might have been thought of by any one," or perhaps "that it is one of those things taken on trust, because it is apparently too plain to require a moment's consideration." Tactics being the order or disposition of an army, and evolution the movement which conducts to that order, it is quite clear that however great a tactitian a general may be, the smart carrying out of the new order is dependent on the evolutions or manœuvres of a battalion. Although the manœuvring of a battalion has not been looked upon as a science, still it must be allowed that it is at the root of all field movements.

The fate of a battle, particularly in modern warfare, is often dependent on a brigade or battalion being able to grasp, without loss of time, any advantage offered by the enemy. For that reason it is necessary that manœuvres should comprise every movement that a battalion may be required to perform under the most adverse circumstances.

The subject being one that, to go into properly, requires more time than is at my disposal, I propose touching on the progressive development of infantry only so far as is necessary to strengthen what it will be my endeavour to prove, namely, "that a further development is

possible and necessary." The changes that have taken place in the drill and evolutions of companies and battalions, since the first introduction of standing armies, have been gradual, and all tending to simplify and accelerate their movements.

Beginning with the position of officers, we find that—

1st. They were posted by seniority, irrespective of companies, in front of the line.

2ndly. They were placed in front of their companies.

And, lastly, changed in most armies to almost the same position they hold in our service.

The strength of companies and battalions have, on the other hand, undergone great changes, a company having ranged in some armies as high as 300 men, the cause for reduction being the difficulty experienced of manœuvring a battalion with rapidity, when composed of such unwieldy units. Italy may be said to have taken the lead in that respect, as her rifle battalions consist of six companies of 50 men each. Colonel Dalrymple, in 1759, while alluding to the strength of a regiment, which was then the same as now, only that they stood in three ranks, says: "The strength of our present establishment is certainly too great. Three hundred files, were it possible to make them march in rugged ground without confusion, must yet be a very unwieldy body. Every body of troops which is not light and active is equally encumbered by numbers as by any other impediment, and subject to fall into disorder in action."

Whatever alterations may take place in drill and manœuvres it is essential the units of battalions and the units of brigades be reduced; the companies to 50 or 60 men, and the battalion to 6 or 8 companies. The unwieldiness of a regiment in line has been, to a great extent, acknowledged, as well as the difficulty at times experienced of a commanding officer's voice being heard.

The reasons generally given for keeping up the establishment of a regiment at its present strength are purely financial:

1st. That the expenses of working a battalion 1,000 strong are the same as 600.

2nd. That the expenses of keeping up bands, messes, etc., would be too great for a smaller body of officers and men.

Might not those administrative difficulties be overcome without affecting the efficiency of a battalion in the field?

Without going back to that period when companies were formed eight deep, the alterations that have taken place prove that more is daily expected from the soldier, and that the period is not far distant when his training will have to undergo that radical change which is necessary to enable the evolutions of battalions to keep up with the destructive powers of modern weapons which the ingenuity of man is daily inventing and improving.

We find that from two ranks the more careful training of a soldier has enabled us to obtain greater results than from the old formation of four or three; no doubt owing, also, to the superior arm we have placed in his hands.

In looking over some old and valuable works belonging to the

library of this Institution, and also that of the British Museum, I have been very much struck with the fact that although important changes and alterations have been suggested from time to time by officers of great experience, they have been allowed to lie dormant for years, and that nothing but bitter experience in the next war has been able to produce the changes suggested and required. However, it is but justice to add, that owing to an enlightened spirit, which is gradually finding its way into the administration of all armies, improvements, in spite of unnecessary routine, are daily taking place, and that the army is more and more, particularly in this country, acquiring the right of being called a profession that demands study and application, and not a pastime. To quote Captain Mountsteven, who, in 1842, aimed almost at the same thing as myself, "celerity and security are the great points to be attended to in manœuvring." No manœuvre should ever be permitted on parade which cannot be used in action; but also that our system should be so complete as to guard regiments against the risk of being forced into movements in presence of an enemy, which they are not in the habit of constantly practising elsewhere.

Indeed, the whole subject may very fairly be brought within the two following propositions:—

First. Does the existing system provide a manœuvre suited to every situation in which a battalion may require to be placed in action, or into which it is likely it may be forced by the enemy, to the exclusion of all others; and are the movements so provided, performed in the quickest way possible, as well as in that in which there is the least chance of mistake?

Secondly. If this be not the case, how can a system be provided that will remedy those defects?

The answer I would venture to give is:

First. *By studying the individuality of the soldier.*

Secondly. *By so simplifying all movements as to ensure their rapid execution without intermediate words of command;* and,

Lastly. *By wording all commands in such a manner as to clearly indicate what the next movement will be.*

First. *Studying the individuality of the soldier.*

The introduction of arms of precision has, to a certain extent, cut at the root of the old system, and turned the attention of all countries, especially of our own, to the necessity of at least instructing the soldier in the use of his rifle. That important end having been attained, the next question is, how far, with due regard to rapidity, the present drill can be so simplified as to enable the soldier to understand the movement in view, and act without the numerous aids, which at a critical moment may fail.

If a soldier is conscious that the smartness of a movement is dependant on his own individual exertion, it will give him greater interest in his work, and will be an incentive to acquire his duties. But if he is only looked upon as a mere machine, it will be impossible to give a battalion that elasticity which is so essential to further development. It is the idea, that from a man in the ranks nothing more than obedience is required, that makes him careless, and depend on the

assistance of his superiors. If, instead of useless guard-mounting, as is too much the case in our large garrisons, the soldier's time was taken up in his mental and bodily training, it would add to his health, efficiency and happiness, and also induce a superior class of men to join the army. It is only by raising the soldier in his own estimation and that of his fellow-citizens, that you will be able to improve the moràle of the service, and abolish that demoralising system of recruiting at present in force.

The Marquis of Santa Cruz says, "One should accustom soldiers to throw up earth, to make fascines, and to place them properly, to plant picquets, to know how to make use of gabions to entrench with, making the ditch, parapet, and banquette, where the engineers shall trace them, or the parapet and banquette only, taking the earth from within, as is done in the trenches made for the attack of a place; for when there is occasion really to perform these works, the soldiers who are not well practsied in them, will find themselves quite at a loss, and will do them both slowly and imperfectly, particularly if in presence of an enemy."

By the mental training of a soldier, I may, perhaps, mean more than most people will allow to be necessary, still experience has taught, that intelligence will often cope successfully with courage and numbers. The strides that science is daily making, and the loss of life and treasure that is entailed by modern warfare, demand that the soldier should receive the highest training that can be given him; so that the country in return for the great sacrifice that war entails, should be enabled to secure the greatest results. His mental training ought to consist of a knowledge of reading, writing, arithmetic, first outlines of geography and military history; theoretical, as well as practical instruction in company, battalion, and light infantry drill, musketry, and first outlines of field fortification; a necessary knowledge of cooking, and making himself at home under all circumstances. In his bodily training, I would include gymnastics, sword and bayonet exercise and swimming.

It is by thus studying the individuality of the soldier, that you will give him that confidence in himself, which will make him try, and if possible overcome, all obstacles that may present themselves. Courage and science combined, going a long way towards ensuring victory.

Secondly. *By so simplifying all movements as to ensure their rapid execution, without intermediate words of command.*

Colonel Dalrymple, more than a century back said, "The art of the manœuvre of troops consists only in distributing motion equally to every part, so far as can be, to enable the whole to form or change their positions in the most expeditious and best method to answer the purposes required of a battalion, brigade, or line of infantry. It becomes necessary to introduce a plain and easy method how the front may be expeditiously changed to oppose any sudden and unforseen attack on either flank." The drill book of 1770 says, "That all manœuvres be executed by one single order, and that they be as simple as possible." And lastly, Captain Mountsteven adds, "I consider the true system of acting in the field to be, not only to perform

those manœuvres which are absolutely necessary in the quickest and plainest way possible, but also never to make any alteration in our formation in presence of an enemy, unless we cannot avoid it without manifest disadvantage. I know not in what way a more successful effort can be made to circumscribe its limits, than by altering our manœuvres until they become as simple, practicable and complete, as they are capable of being made. The three quotations I have made will be sufficient to prove, that the principle of simplifying and accelerating all movements, has been acknowledged for the last century and a half, and is still only partially carried out.

All movements, whether company, battalion, or brigade, may be divided into *actual formations*, and *intermediate movements*. An actual formation, being the result of intermediate movements, and a position in which a body of men would receive or attack an enemy. Actual formations may again be divided into—

Formations in line,
" " column,
" " echellon,
" " square, and
" " extended order.

All other sections in the drill-book must necessarily come under the head of intermediate movements; that is movements necessary to enable a battalion to change from one actual to another more suited actual formation.

It is on the simplicity of these intermediate movements, that the successful accomplishment of an actual formation depends.

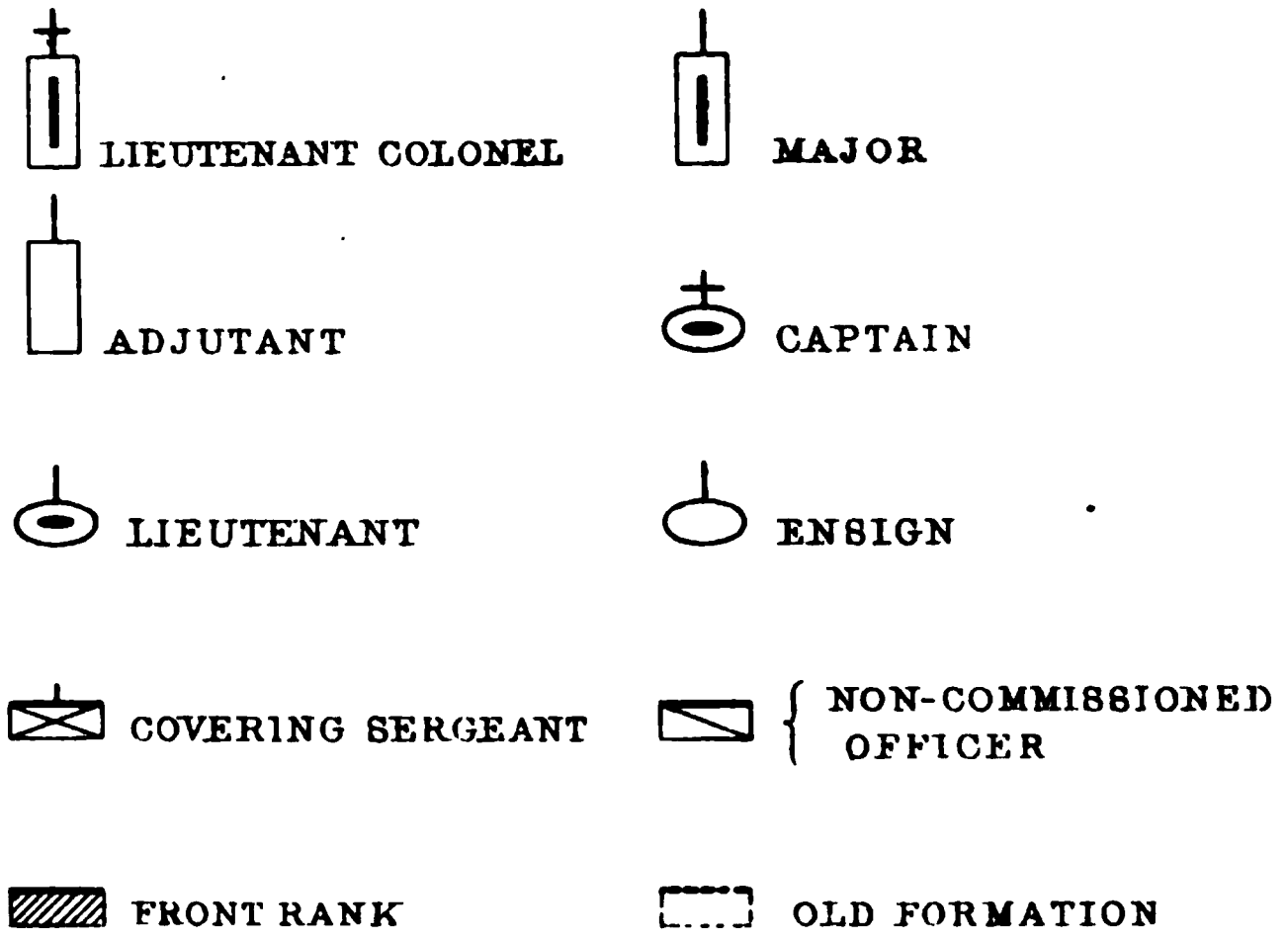
Assimilating the movements and words of command of a company with those of a battalion, will also tend to make the acquirement of drill easier, and less liable to confusion.

Captain Mountsteven says—"To obtain rapidity, a corps must always "move by the shortest and most direct way, from the formation it "may happen to be in, without any regard to its being what is termed "clubbed, or as to which rank is in front." In other words, on the directness of intermediate movements, from one point of formation to another, will depend rapidity of execution. It need hardly be added, that if the present system deprives the commander of a battalion of that liberty of action which is so essential, how much more so must it not hamper a brigadier, and so on.

As it would be impossible in a lecture to go into the minutiæ of all the changes proposed, I will confine myself by stating the reasons why some movements may be entirely omitted, and how others may be simplified. To avoid mistakes and enable a commander to alter the order of companies, I would suggest that off parade they should be lettered as *A*, *or Captain Smith's Company;* and that the telling off of a battalion be resorted to as often as needed, either from the halt or on the march.

In section 43 of Squad Drill, and section 17 of Company Drill, I would introduce the following alteration:—"That a squad or company can front-form company to either side of the leading file, according to Fig. 1, Plate XXI, without regard as to whether its right or left in

KEY TO PLATES.



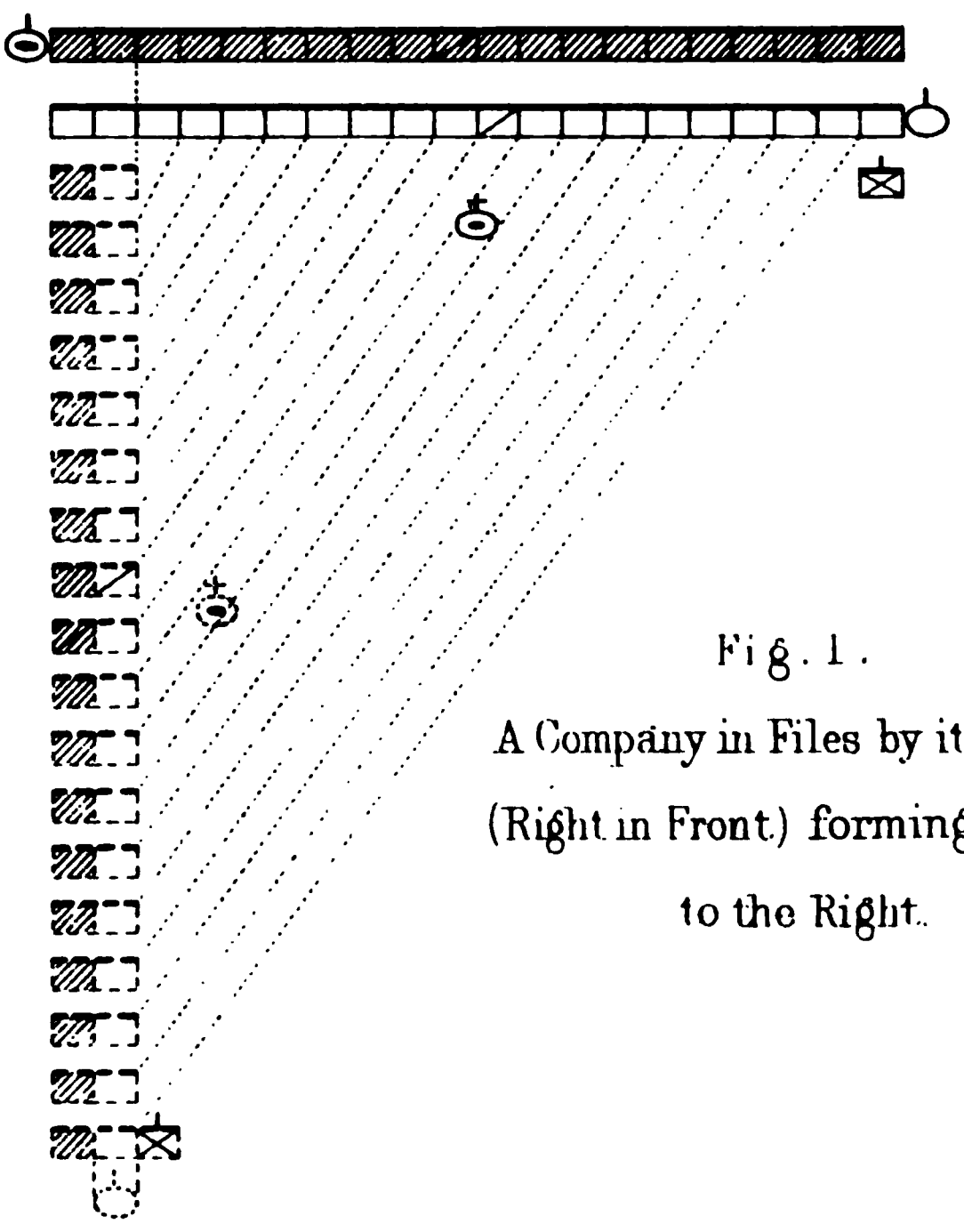
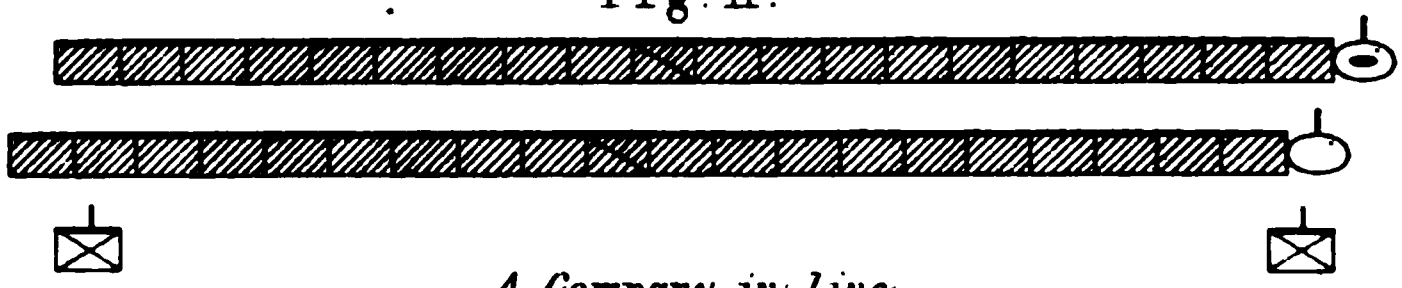


Fig. 1.

A Company in Files by its Left (Right in Front) forming Front to the Right.

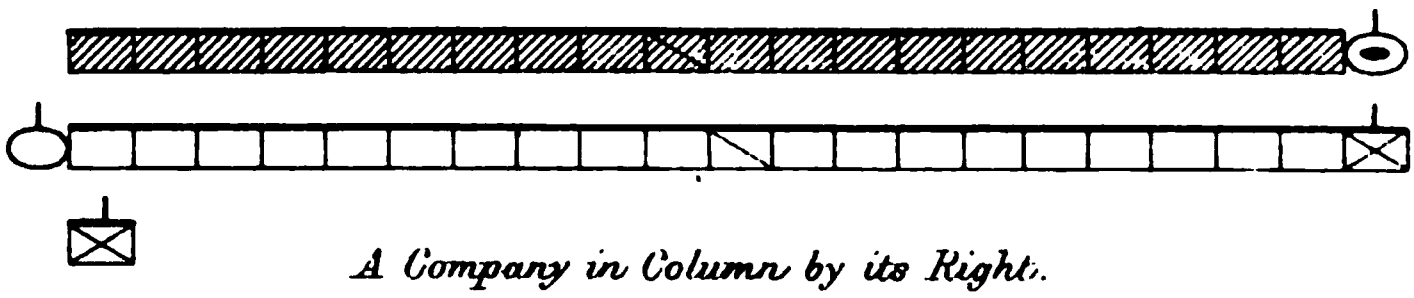
J R Jobbins

Fig. II.



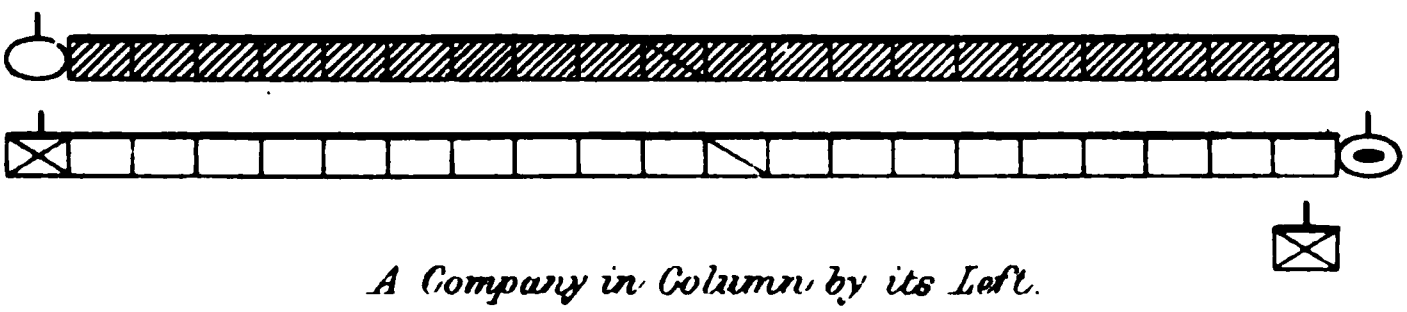
A Company in Line.

Fig. III.

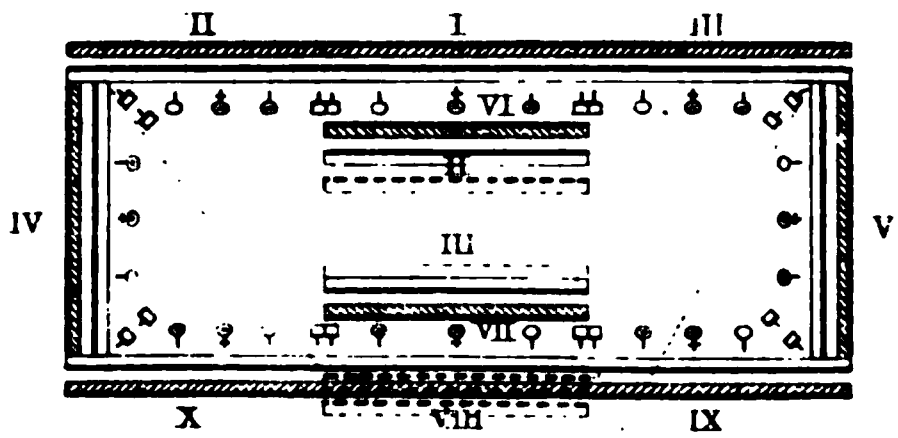


A Company in Column by its Right.

Fig. IV.



A Company in Column by its Left.



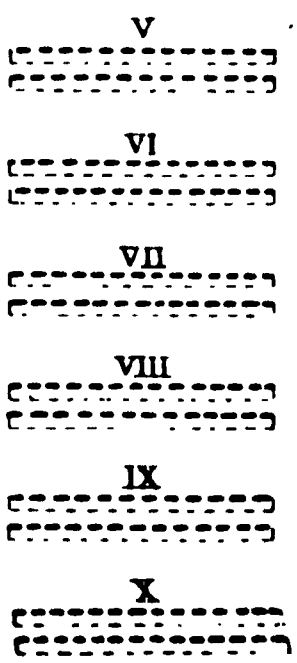


Fig. VI.

A Battalion in Quarter Distance Columns forming Square on the leading Company

front, or, according to the new system proposed, by its right or left." The word of command would be *right, or left, front-form company.*

In section 1 of Company Drill, I would suggest the following alteration :—" That on the caution '*as a company in line,*' (see Plate XXII, Fig. " II) the captain should place himself in rear of the centre of his com- " pany. The lieutenant on the right of the front rank, the ensign on " the left of the rear rank; 1st covering sergeant in rear of the right " file; 2nd covering sergeant in rear of the left file; and the 3rd ser- " geant in rear of the left front rank man of the right sub-division; " the 4th in front of the right rear-rank man of the left sub-divi- " sion."

The reasons for placing the captain in rear of his company are—

1st. That it enables him to give his men that superintendence which is essential and at present impossible, and

2ndly. That it gives him liberty of moving about and attending in person to any derangement or mistake that might occur.

By altering the position of the ensign and reducing the number of the supernumerary rank, it will enable a commander to invert the order of ranks as it suits him best.

In section 2, as a company in column, right or left in front, I shall include *countermarching* by *ranks, files,* and *sub-divisions.*

Unfortunately, an idea has been taken up that it is absolutely necessary always to keep one and the same rank in front; to accomplish which end, many round about, intricate and slow movements were introduced, all of them totally useless for any other purpose. In fact it may be said, that owing to it, our movements labour under the great disadvantage of being nearly doubled in number and more than doubled in complication. The position of a rank in a company, or a company in a column ought to be no longer considered. In fact it should make no difference to the denomination or action of a battalion, which of the two ranks happen to be in front.

Captain Mountsteven says, " The principle change now proposed in " a long tried system may be thought to be too violent; but it must " be recollected that our still long and complicated set of manœuvres " cannot be materially shortened and simplified without it: for every- " thing has been done already to that end, which can be done whilst " we retain our present plan, with regard to the use of the ranks. It " must also be remembered that no new forms for meeting an enemy " are contended for, but only safer and more expeditious methods of " executing those which already exist."

The improved method of sizing a company, as at present in force, by making the rear rank the same height as the front, and the faulty system still adhered to in some countries, of placing the most efficient men in the front rank, having been done away with, obviates the necessity of trying as much as possible to keep a certain rank in front, a rule which must necessarily hamper a commanding officer, and deprive him of that liberty of action which is absolutely necessary to enable him to show a front under all circumstances.

There certainly is a sanction given in the drill-book for inverting the order of companies, but still why, instead of being sanctioned,

should it not form part and parcel of the system? The sanction implies that a necessity might arise for putting into force what is only partially recognised as necessary. A system should be laid down and no deviation allowed.

For the reasons given, I propose the following alterations:—

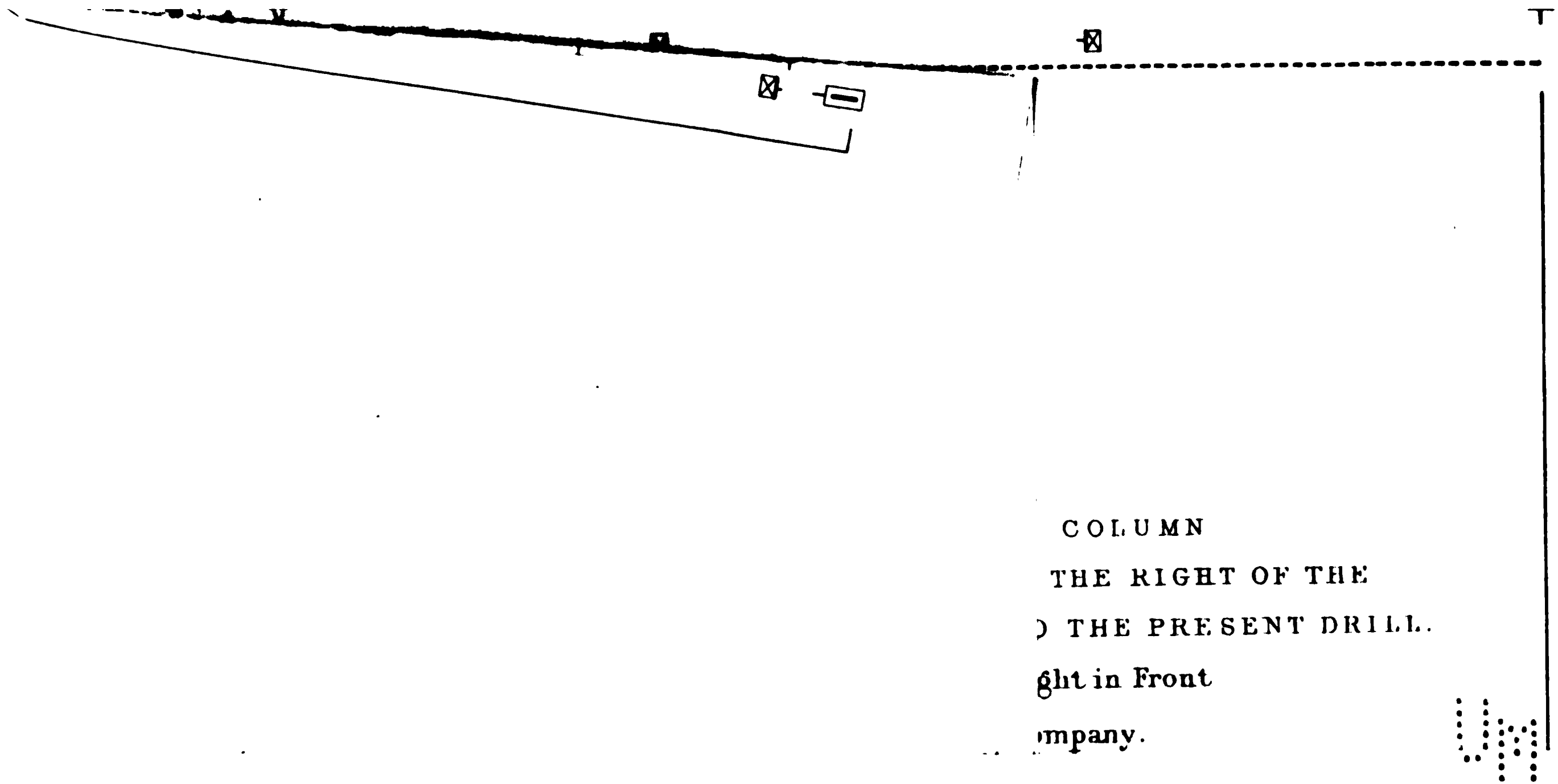
First. That instead of "as a company in column right or left in front," it should be, "*as a company by its right or left*" (Fig. 3). On the caution *by its right*, the officers and supernumeraries would fall in as a company in line, excepting the right covering sergeant, who places himself in rear of the lieutenant. On the caution, "*by its left*," (Fig. 4) the lieutenant will place himself on the right of the rear rank, and the ensign on the left of the front rank, left covering sergeant in rear of the ensign, the captain and remaining covering-sergeant as in line. To save repetition, it may be stated once for all, that the captain always retains his position in rear of the company.

The second alteration I would suggest is, that countermarching by ranks, files, and sub-divisions be omitted as a roundabout way of accomplishing what may be effected in a speedier and simpler manner, by "*facing about* and *denoting the pivot*." The result will be this: that if it was desirable to change the front of a company or column permanently to the rear, and still retain the same alignement, all that is required, if they have been marching by the right, is "*right-about turn*." On the caution "*turn*," the captain will pass through the centre to the new rear (by which an advantage will be gained of keeping up correctly the telling off of pivot men of sub-divisions), the covering-sergeants will pass round the outward flanks of their companies. On the caution, "*by your left*," the lieutenant will step up to the new front rank, and the ensign will fall back to the new rear rank. But if it is desirable to change the alignement on the *caution* "*by your right*," the lieutenant and ensign will retain their former positions.

Formation of Column from Line.—As the formation of column from line and deployments often take place under fire, with little time to do them in, it becomes doubly necessary that the intermediate movements should not be dependant on endless secondary commands, as in action, they might easily not be heard, and in consequence produce confusion. For that reason I propose, 1st,—that to complete either formation, intermediate words of command should be abolished; and, 2ndly,—that the intermediate movement should be in files, or close columns of sub-divisions, instead of fours. Fours may do very well for route marching or parade purposes, but for moving in the face of an enemy they are impracticable, as no officer would dream of telling off a company, when casualties were frequently occurring.

To quote Captain Mountsteven, with regard to the formation of threes, "it would have a bad effect physically, as after taking off your attention to no purpose, it would only enable you to do that which would be done better by filing; and a much worse, morally, by constantly reminding the men of the loss they were sustaining.

The manner in which I think the number of commands might be reduced to one, and the movement simplified, is thus:—On the cautionary word of command—


COLUMN
THE RIGHT OF THE
) THE PRESENT DRILL.
ght in Front
mpany.

Open, quarter, or *close column, right or left,*
" " " " *in front, right or left,*
" " " " *inwards,*

the whole, excepting the company on the flank denoted, would face in that direction. On the word "*Quick march,*" supposing the formation to be *Open column right,* the remaining companies will move off led by the officer who happens to be on the right; the right covering sergeants (that is the sergeants in rear of the right of companies), excepting those belonging to the company upon which the formation takes place, will double out and take up the point where the left of the companies will rest in column. The companies will pass round the covering sergeants as at present, and will halt and front in succession by files as soon as the leading file has closed on the officer, who will halt and front the moment he finds himself square to the front.

Should it be necessary to form the column in front of the left, the word of command will be "*Quarter distance column in front, left,*" upon which the whole, excepting the left company, will face to the left. On the words "*Quick march,*" the left covering sergeants will double out, and mark where the right of the companies will rest, and so on, as in the previous movement.

Deployments.—The present system of deployments, although easy to the eye, is dependent on too many aids and contingents. For instance, should, in the heat of action, the captain of No. IV not hear the "halt, front, dress" of the captain of No. V, in deploying on a rear company, he will march further than required, and at once cause a break in the formation, which, as often is the case, may be expected to open fire at a critical moment. The constant warning of the sergeant-major, that three files are out from the right of No. IV or VI, proves also that the intermediate movement is wrong in principle.

Premising that the equality of ranks has been established, it enables deployments to be immensely simplified, so as to ensure their accomplishment under fire, either from the halt or on the march; the latter being an advantage of which a commander is deprived. At present there is no possibility of a battalion advancing in a compact form, like close or quarter distance column on an enemy, and suddenly deploying whilst on the march, a favourite mode of attacking with the French.

The second advantage secured by not studying the order of companies is, that it does away with that showy but complicated and slow movement of deploying on a rear company, as all deployments, according to the system proposed, will take place on the front; and, lastly, it enables men to open fire the moment a file has formed up, without waiting for the whole company. The command would be simply—

"*Deploy right,*"
" *left,*" or
" *outwards.*"

On the word "*Deploy right*" (Fig. V, Plate XXIII), the whole, excepting the leading company, will face to the right, or form close column of subdivision. At the word "*Quick march,*" No. II will wheel smart to its left, led by the officer that happens to be on that flank; and on the front rank man of the leading file being in line with the rear rank man of the

right file of No. I, he will halt, and his rear rank man will form in front of him, and so on in succession, or in other words No. II will right front form company. The remaining companies led in the same way, will move up and along the rear of the company already formed up, and on the front rank man of the leading file arriving in line with the last file of the preceding company, will form company on the leading file to the left, only with reverse ranks. If desirable for parade purposes, covering sergeants may double out in succession, and take up points. The captains will always superintend the heads of their companies. *Deploy left* will be done in the same way. *Deploying outwards*, which will take the place of deploying on a central company, will be effected in the following manner:—On the word "*Deploy outwards*," the leading company will stand fast, Nos. II, IV, VI, and VIII will face to their left; Nos. III, V, and VII will face to their right. On the word "*Quick march*," even numbers will deploy as a company deploying left, odd numbers as a company deploying right.

Another advantage obtained by deploying in this manner is, that if the formation is taking place under fire, that the intermediate movement is to a certain extent screened by the companies already formed up, an advantage not to be undervalued, as it tends to keep men cool and collected, and give their attention to the formation they are expected to accomplish.

Squares.—The few instances that we have of squares being broken by cavalry renders it more useless than ever, and a waste of time in forming them four deep, particularly when we consider the long range of rifles, and the superior practice of infantry. In fact, it may be said that by the introduction of breech-loaders, which must take place shortly, the necessity of forming squares at all will be very much diminished. It is a formation which is extremely cumbersome and dangerous, particularly when we take into consideration the preponderence of artillery in proportion to other branches of the service that modern armies are expected to have. One battery of 6 guns and two howitzers to a brigade of 5,000 or 6,000 used to be the proper complement in most foreign armies; now it is more than treble, and in many cases more than that.

The word of command for forming square would be simply, if in line, *Form square, right, left*, or *centre;* if in column, *front* or *rear*.

If in quarter distance column, on the caution *Front form square* (Fig. VI) companies Nos. I and VIII will stand fast, Nos. II, IV, and X will face to the left, Nos. III, V, and IX to the right. On the word *Quick march*, Nos. II and III deploy on No. I, Nos. IX and X deploy on No. VIII, No. IV forms the left, No. V the right face of the square, Nos. VI and VII form the reserve, and Nos. VIII, IX, and X will close the square; Nos. IX and X in deploying on No. VIII, will deploy as on the march by Nos. IX and X, breaking into double time till formed up.

If in line, on the caution *Form square left*, the whole, excepting the three companies on the left flank, will face to the left. On the word *Quick march*, No. VII will move close along the rear of Nos. VIII, IX, and X, and left front form company; No. VI, the leading file, will halt, face to the rear when in line with the front rank man on the left of

Fig. VII.

A Battalion in Line forming Square in Rear of the Left.

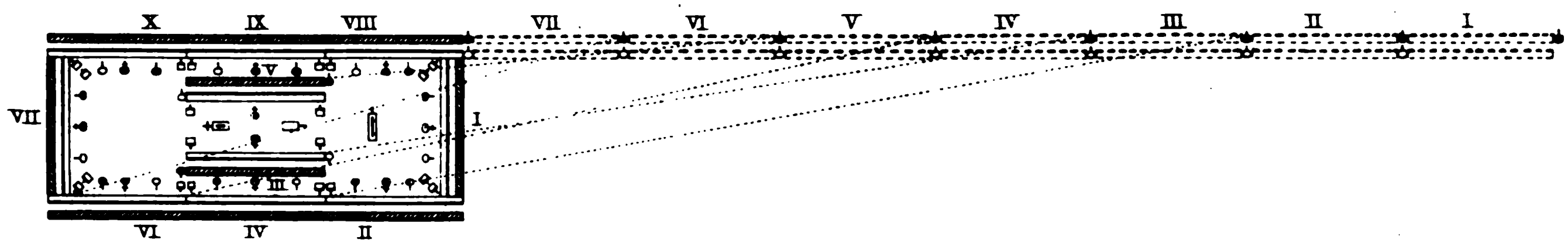
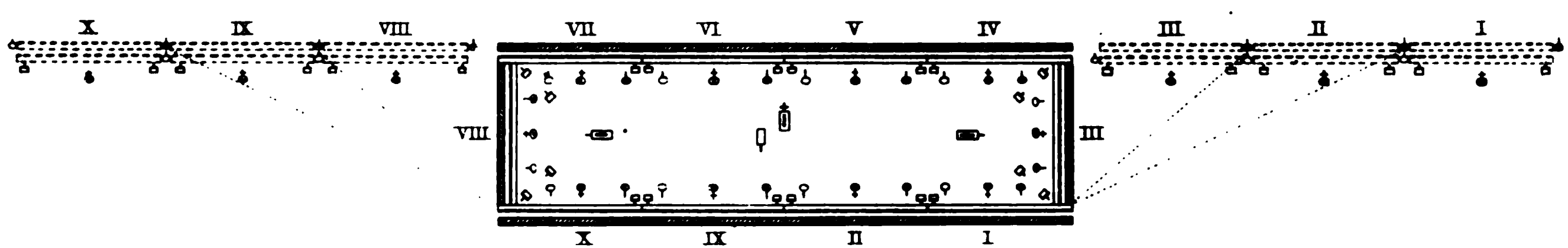


Fig. VIII.

A Battalion in Line forming Square, without Supports, in the Rear of the Centre.



No. VII, and so on in succession; No. V will halt and front in close column distance when in rear of No. IX, No. IV will form up like VI on the left of that company, No. III will halt at close column distance and face to the rear, in rear of No. IV, No. II will form as No. VI, but on the left of No. IV, No. I will close the square by forming company to the right about on the leading file.

On the caution *Re-form column*, No. I will stand fast, Nos. II, III IX, and X will face inwards; No. IV will face to the left, and V to the right; Nos. VI, VII, and VIII will face about. On the word *Quick march*, Nos. II, III, IX, and X will form column in rear of Nos. I and VIII, No. VI will halt in rear of No. III, and No. VII in rear of No. VI, No. IV in rear of No. VII, and No. V in rear of No. IV.

Fig. VII, Plate XXIV, illustrates a battalion in line forming square in rear of the left with supports in the centre, according to French system.

Fig. VIII represents a square, without support in the centre, formed by a battalion in line in rear of the centre, a formation which has the double advantage of being quickly and easily formed, as well as changed into any other formation.

Lastly. *By wording all commands in such a manner as to clearly indicate what the next movement will be.*

As the object of this must be obvious, it will be sufficient if I place side by side an old and proposed new word of command.

Instead of *change front on the centre, right thrown forward*, I would try and assimilate company with battalion command, and say *company* or *battalion on the centre right wheel.*

In conclusion, I beg to add that I sincerely hope that the system I have this day attempted to advocate may not suffer by the imperfect manner in which I have illustrated it.

Question by Capt. PACKE: Who is answerable for the distance in column?

Answer: The officer on the pivot.

Question by Captain BENNETT: Why are the subalterns placed one in front and one in rear?

Answer: To divide the superintendence, and denote the pivot more clearly.

Question by General STANHOPE: Are both ranks to be equal?

Answer: Yes; in every respect.

Evening Meeting.

Monday, May 2, 1864.

COLONEL P. J. YORKE, F.R.S., in the Chair.

NAMES of MEMBERS who joined the Institution between 25th April and 2nd May.

ANNUAL.

Pratt, Lord Geo. M., Lieut. Gren. Gds.
Garratt, J. A. T., Lieut. Gren. Gds.
Trotter, Henry, Lieut. Gren. Gds.
Thomas, C. D., Lieut. Coldstream Gds.
Lewis, G. O., 7th Royal Fusiliers.
Rycroft, C. A. W., Cornet Hants Yeo. Cavalry.
Colvin, W. B., Capt. 7th Royal Fusiliers.

ON THE EMPLOYMENT OF CAST-STEEL FOR THE MANUFACTURE OF ORDNANCE AND PROJECTILES.

By H. BESSEMER, Esq.

FROM the time when the highly expansive force of gunpowder was first discovered down to the present, the material best adapted for the construction of ordnance has occupied the attention of the artillerist.

The employment of bronze for this purpose at one period had become almost universal, and it was not until the time of Elizabeth that guns were founded in iron at Tunbridge, of a quality calculated to supersede those of bronze. Since that period, however, the employment of iron in the manufacture has gradually extended, until it has almost wholly replaced the more expensive alloys of copper.

As it would be entirely foreign to the purpose of this paper to give even a sketch of the early history of artillery, we may at once turn our attention to the present state of that manufacture.

Cast iron as a material for ordnance possesses some advantages which it is impossible to ignore; it is inexpensive, and can be founded with great facility even when of the largest size. The simplicity of structure, arising from founding such guns in a single mass, is no mean advantage; in these guns there is no delicacy of structure, nor are there any fine parts to give way or spoil by a slight corrosion; these

are points of no little importance in the rough necessities of actual warfare, indeed in this respect they stand far above the modern built up wrought-iron gun. Cast iron, when of the excellent quality made by the Low Moor Company, has proved itself a most valuable material for the artillerist; it does not, however, combine in itself all the qualifications essential to the perfection of modern ordnance and projectiles. When large masses are founded, crystallisation takes place very slowly; these crystals are more or less perfectly developed, and their coherence is consequently diminished in the same ratio; the grain of the metal becomes open and porous, while some of the carbon in the form of graphite, separate more or less from the metal, and by interposing itself between the crystals, still further weakens their hold one upon another.

Many attempts have from time to time been made to improve the quality of iron for the gun founder, and not without a measure of success. At the Royal Gun Foundry in Vienna, a reverberatory furnace, known as Ecke's furnace, is employed to melt and refine the metal. In this furnace carbonic oxide gas, generated in an adjoining chamber, is employed; jets of this gas and atmospheric air are introduced into the melting chamber, and when the fusion of the metal has taken place on the circular hearth, two jets of air are forced diagonally upon the surface of the metal, from opposite sides of the furnace, so as to cause a slow rotation of the metal on the hearth, and thus bring every portion in turn under the influence of the jets, the result is a certain degree of purification of the metal, which is said to considerably increase its tenacity, and otherwise render it more suitable for the founding of ordnance. The re-melting of iron several times in succession appears by the very interesting experiments instituted by Mr. William Fairbain, also greatly to improve its tensile strength; the effect upon the metal and its constituents being practically much the same as that produced in Ecke's furnace.

Among the improvers of cast iron the name of Morris Stirling holds a prominent position. This gentleman's invention consists in melting wrought iron scrap, with cast iron, in the cupola furnace; by this means it is probable that a higher degree of refinement is given to the metal than could be attained by either Ecke's furnace or by a succession of meltings. This invention of Mr. Stirling's would have well repaid a further investigation, and deserves more success than it has met with; doubtless the difficulty of fusing the wrought iron in the cupola furnace, and the uncertainty of the mixture arising from that cause, has prevented its more extended use.

Another mode of improving the quality of cast iron for founding purposes has lately been introduced, the application of which to the founding of ordnance would be most interesting. For this purpose iron as highly carburetted as possible is preferred, because such iron, by melting in the blast furnace at a lower temperature, is more pure than metal obtained from the same materials in a less carburetted state. When this metal is in a state of fusion, from one-third to one-half of its weight of molten malleable iron, or molten steel, may be poured therein, direct from the Bessemer apparatus, and be then

mechanically stirred together, the mixture taking place in a casting ladle placed on a suitable weighing machine, so that the exact quality of metal desired may be arrived at by accurately weighing the crude and malleable metal before mixing them together. The highly carburetted condition of the pig iron admits of a large proportion of the malleable metal being used therewith, without rendering it too hard for founding purposes.

This mixture of steel with cast iron not only gives a very fine and close grain to the resulting metal, but it entirely prevents the separation of carbon in the form of graphite during its cooling and crystallisation; it may be cast in ordinary sand or loam moulds with the same facility as ordinary cast iron, while its resistance to compression and its tensile strength are very greatly in excess of any known quality of that metal. One of the stamp-heads employed for crushing quartz, made of this mixed metal by casting in an iron mould, is before you on the table; it contains a few air bubbles, in consequence of the rapid cooling of the metal in an iron mould. One end has been broken off in order to show the beautifully fine grain of the metal, which is semi-malleable, and capable, at a blood-red heat, of being hammered from a 6-inch bar to a 5-inch one, without fracture.

For the construction of mortars and ordnance designed to throw spherical shot or shell, and where the strain on the material is not excessive, this simple and inexpensive mode of founding ordnance in a semi-malleable metal may lead to important results. The founding of ordnance in steel and the employment of it in its cast or unforged state, does not, however, appear to offer the advantages which the application of so excellent a material as steel would lead one to expect. It must also be borne in mind, that the casting of this metal in large masses is attended with great difficulty, and its soundness and freedom from air bubbles is by no means easily insured. These difficulties in founding steel have, however, been lessened to a very great extent, if not wholly surmounted, by Messrs. Naylor, Vickers, and Co., of Sheffield, who have made great progress in the art of founding in that metal, but there still remains the fact, that steel as cast, and while still in the unhammered state, possesses only about one-half of the cohesive force which the same piece of metal will acquire when hammered or forged, nor will a cast bar bend without fracture more than 4 or 5 degrees from a straight line, but when hammered it may be safely bent to an angle of 45 or even to 90 degrees without giving way. When therefore we consider how small is the labour and expense of hammering a mass of cast steel, and that its resisting powers may be doubled by that means, it will be seen that its use in the unhammered state should only be resorted to in cases where the shape of the casting renders hammering extremely difficult or impossible.

The difficulties felt by the artillerist in obtaining cast guns capable of withstanding the severe strains which the system of rifling and the employment of elongated projectiles necessarily entail, has forced their attention to the best means of employing malleable iron in the construction of ordnance. All attempts to effect this object on a large

scale are attended with great difficulty, and uncertainty as to the final results, however good in its original state the bar iron may be that is intended to be made into a massive forging. We have no positive assurance that the same excellence of quality will survive the repeated heatings and hammerings, which it is destined to undergo, before the forging operation is complete; nor can we tell how much of the oxide which accumulates on the surfaces of the bars may be shut up between them, and produce flaws and weak parts in the forging; nor is it easy to determine to what extent the contractile forces of the mass in cooling will induce strains, tending to rend open the interior of the mass.

As the forging proceeds from day to day, and week to week, its temperature rising and falling with every fresh "heat," and its particles undergoing a continuous change of position, by the alternate expansion and contraction of the mass, as well as by the blow of the hammer, need we wonder that the natural tendency of iron to assume the crystalline form (when favoured by excessive heat and motion among its particles) is felt throughout the mass, which gradually looses its peculiar fibrous texture, and becomes more or less crystalline. The law of crystallisation by which the size of the crystal is governed by the size of the mass of matter, and the time occupied in the formation of them, has its full effect in this forging operation, and not unfrequently produces crystals, whose planes are nearly an inch in extent, and so distinct from each other, as to require but a small amount of force to separate them; with all these sources of difficulty in the way of the manufacture of heavy wrought iron ordnance, it is almost impossible to appreciate sufficiently the successful manufacture, by the Mersey Steel and Iron Company, of the monster gun manufactured and presented by them some few years since to the British Government, at once a monument of official apathy and neglect, and of the skill and enterprise of its manufacturers. In order to avoid the difficulties of producing large masses of forged iron, many plans of building up wrought iron guns have been proposed, among which the plan adopted by Sir William Armstrong has come most prominently before the public; the gun in this case being composed of a series of cylinders, formed by coiling a bar of wrought iron around a mandril, and then welding the adjacent sides of the coil together; it is quite clear, that by so doing much of the danger attending the forging of the large mass is avoided; it is true the welding heat, also necessary in this case, may deteriorate the metal more or less, but it is not likely to do so to the extent which is almost unavoidable in forming a large solid forging, the grain or fibre of the metal is moreover laid in such a direction as to obtain the greatest resistance to the bursting of the tube, but for these advantages, how much is sacrificed! the simplicity of the structure is entirely gone, the skill and labour of boring, and fitting accurately, successive rings over each other, adds enormously to the cost of guns so constructed, and unless each of these fittings be perfect, the coils may be acted on, one at a time, and so becomes destroyed piecemeal. If the contractile force of the metal forming each coil could be perfectly adjusted in the first

instance, and never afterwards underwent a change by constant firing, or by the heating and cooling of the gun; then bar iron might in this way be advantageously employed. But we find these wrought iron tubes so long and pertinaciously adhered to now giving way to tubes of cast steel, over which little coils of the weaker metal iron are fitted, thus keeping up the semblance of the original Armstrong mode of construction, while its principle is thus practically ignored, even by Sir William himself.

With reference to iron, such as that employed in the form of square bars for the Armstrong gun, it may be observed that there are many practical men who still believe that the welding of the several pieces of which the original pile is composed, is so perfect, that the pieces constituting the bar have become one; such persons hold that an *union*, and not a mere *adhesion*, of the surfaces has taken place; this, however, is not the case, for bar iron of the highest brand made in this country, has been repeatedly tried, and as repeatedly has utterly failed to hold together, when subjected to the amount of fatigue which the Bessemer steel stands with impunity. We have before us a portion of an iron bar of a justly celebrated brand; this bar, if worked at a welding heat, under ordinary circumstances would have held together, and might have been fashioned successfully into any article required; but instead of this, the bar was submitted to the action of a sharp, quick, hammer, giving from 300 to 400 blows per minute, the heat being a full red, but a little below the welding point, so that *no* new welding of the parts takes place as the work proceeds; no piled metal *can* withstand such severe fatigue, all the old joints soon begin to open up, and long before the section is brought down to half an inch square, it becomes simply a bundle of fragments; from this it is clear, that if a welded joint were really a true union of the metal, this splitting up could never take place. To show, however, that mild steel is capable of enduring a vastly greater amount of fatigue, a bar of ordinary mild Bessemer steel was submitted at the same temperature to the same hammer, but although reduced to less than one-two-hundredth of its original bulk, it is still without a flaw, indeed, such a separation is as utterly impossible in cast steel, as solidity is an impossible condition in piled or welded iron. The future must determine whether the repeated concussions to which a gun is subjected when in use will produce a similar disintegration of the numerous joinings that pervade the entire structure. Among all the various conditions under which the metal iron is known in commerce, none appears so entirely to combine in itself the qualities essential in the construction of ordnance, as are found in well hammered mild cast steel. The resistance of cast steel to compression, according to the American experiments, quoted by Mr. Mallett, has a mean of 295,000lbs., that of cast iron, 125,000lbs., and wrought iron, 83,500lbs., while the tensile strength which these materials are capable of resisting may be taken at 40 tons for mild cast steel, 20 to 25 tons for wrought iron, and 10 to 12 tons for cast iron; thus we find in cast steel a material not only capable of resisting a compressive force far greater than any other known metal, but one whose tensile strength is also

nearly double that of wrought, and more than three times that of cast iron; perhaps in no other point is the advantage of steel over wrought iron more marked than in its power to resist compression, a property to which it would appear that cast iron, so low in tensile strength, owes chiefly its power of resistance.

It will be unnecessary to enlarge further on the well-known fact of the superior strength of cast steel, as compared with iron, in any form in which that metal is known, but it may be interesting to examine its comparative merits, on other points equally essential to the perfection of a material for ordnance. For rifled ordnance, the metal of which the gun is composed should be capable of resisting to the greatest extent possible the wear and abrasion of the rifle grooves, caused by the passage of the shot along them. If we may take as an example the wear of a steel piston ring, or a steel piston rod, or a railway tire or rail, we find that steel has a power to resist abrasion from five to ten times greater than that possessed by wrought iron.

Again as to flaws and surface cracks, caused by the imperfect union of the numerous pieces of wrought iron composing a gun, it may be truly said, that no amount of human skill can prevent the formation of flaws or cracks of greater or less magnitude in the mass of wrought metal, these crevices sometimes outcrop at the most unfortunate point, they not only weaken the metal, but give rise to the fouling of the gun, and when large, may harbour a spark, and do much mischief. In a cast steel gun made from a *single ingot*, all such defects are *simply* impossible.

Another point of considerable importance in the choice of a material for ordnance, is the amount of destructive action which will result from corrosion, for in the rough usages of war, guns will not be so tenderly looked after as on practice days at Shoeburyness, and we must not then expect to look through a delicately polished tube, which delights the eye with a succession of beautiful rings of reflected light; a few months in the trenches, or exposed to the damp saline atmosphere of the sea, assisted by the chemical action of explosive gases, will soon corrode and roughen the interior of the gun. Wrought iron, in consequence of its peculiar formation, presents on its surface innumerable fissures, which, though not visible in some cases to the eye, nevertheless exist. The imperfections of welding which pervade every portion of the wrought mass, produce multitudes of crevices which crop out side by side, and show clearly how the original pile was formed, corrosion follows up in all these little fissures, widening and deepening them, and thus rendering the surface corrugated and uneven. We have only to examine any wrought iron structure that has been exposed to air and moisture, or an old cable, or anchor, and mark its deep, indented surface, to see this fact illustrated.

Cast steel, from having been once fluid, and cast in an undivided mass, is wholly free from this uneven action, when exposed to corroding influences. The two square bars before us afford an example of the different behaviour of the two metals, under precisely the same treatment; one of them is a bar of good ordinary wrought iron, known

as S C iron, the other of Bessemer steel, both were planed true and polished, the ends neatly squared, and the angles left sharp, they were both fastened to a wooden frame, and immersed simultaneously into a vessel filled with a corrosive fluid, consisting of one part of sulphuric acid with ten parts of water, and there left for forty-eight hours; the natural result is, that the iron bar has corroded unevenly, showing clearly the structure of the pile, and exposing to view every welded joint; while the steel has lost only a portion of its outer surface, its figure, with every angle sharply defined, still remaining intact. It is somewhat remarkable that this corrugation of the surface of wrought iron when corroded has not been more considered in reference to the Armstrong gun, where the corroded lines would be nearly at right angles to the rifled grooves, while the angles of the grooves themselves would become serrated, like so many saws. The effect upon the lead-coating of the shot, which even an approach to this condition would produce, can be easily imagined; the advantage which the Whitworth form of rifling presents in this respect is most important; even if he employed wrought iron, the amount of corrosion which would utterly destroy the Armstrong gun, would take little, if anything, from the efficiency of the gun of Mr. Whitworth; but it must be remarked, that this gentleman has advocated and employed cast steel from the commencement, while Sir William Armstrong has as constantly resisted and opposed the employment of a material which, if adopted, would have entirely swept away and rendered valueless his whole system of welded iron coils, and at the same time have deprived him of the monopoly he has so profitably enjoyed.

In order, however, to compete with Mr. Whitworth, it is stated that the very *heart* and *core* of the Armstrong competing gun is made of cast steel; if this be so, the present trials afford no test whatever of what the country is most anxious to know, namely, what are the real capabilities of the coiled and welded iron tube, on the manufacture of which such a vast amount of money has been expended.

To return, however, from this digression, to the consideration of cast-steel as a material for the construction of ordnance; it has already been shown that its tensile strength, and resistance to compression, its freedom from wear and abrasion, its perfect freedom from cracks or flaws, and also its behaviour under corroding influences, offer the most important advantages over wrought iron; it therefore only remains to be seen, if ordnance made of so desirable a material can be produced with more or less ease and certainty than guns constructed by forging, or building up, in wrought iron. Although cast steel is not a new material in the arts, yet cast steel of the mild character approaching to iron, such as alone should be employed for ordnance, is not easily obtained, by the ordinary process of melting steel in a number of small crucibles, more especially where large masses are required; but notwithstanding these difficulties, the fact that large masses of steel can be made successfully by such means, was abundantly proved by Mr. Krupp at the International Exhibition, where he achieved a success, which still leaves him without a rival, in the manufacture of large masses of crucible steel. It must be

observed that Mr. Krupp not only has made large masses of steel, but he has successfully fashioned them into guns, of which the Prussian Government alone are said to have more than 1,000 of various calibres.

It is stated on reliable authority, that the employment of steel guns in actual warfare, before Dyböl, has been so successful, that the Prussian Government, within the last week, have ordered an additional 300 guns from Mr. Krupp.

The extreme toughness which results from reducing the quantity of carbon in steel to the lowest point, while it greatly increases the risks and difficulty of making large masses of steel in separate crucibles, in no way interferes with the making of steel by the Bessemer process, where the heat generated during its conversion is sufficient to retain the metal in a perfect state of fusion, even when wholly decarbonised and converted into soft malleable iron; so that only as much carbon need be added thereto as will suffice to bring the metal up to the particular quality of steel required. A quality much milder and nearer approaching to iron, than has yet been employed, is deemed by the writer to be indispensable for that purpose, for even wrought iron appears to fail more from its structural imperfections, than from any want of hardness in the metal.

Of all the errors and misconceptions that the public have fallen into in reference to the Bessemer steel process, there is none so utterly without foundation as the idea that this process is incapable of perfect control, and that the results obtained are involved in uncertainty.

In the early stages of so novel an invention, and at a time when not a single workman could be found who understood even the merest routine operations, and when no one possessed the advantages which experience alone can give in manufacturing operations, it need not be matter of surprise, if the results then obtained were not very uniform, and the trade, who had to a man declared the whole process an impossibility, eagerly seized on this fact, which was industriously circulated, and at the same time, like most stories, it lost nothing by the telling. A cry once raised seems to echo, and repeat itself, with redoubled force, although the fact which originated it has long since ceased to exist. One of our first practical engineers, who has used more than 2,000 tons of the Bessemer steel, asserts that it is considerably more uniform in quality than ordinary cast steel, indeed the manufacture as it now stands leaves but little to desire. This cuckoo cry, of want of uniformity, has, however, done some good; for it has caused a strict investigation into all the possible sources of irregularity, and has enabled the writer to effect such an improvement in this process as bids fair in future to turn the tables on its accusers, who cannot hope by the mere examination of their steel by the eye, and thus judging of its state of carburation, to arrive at the certain results to be obtained by a system of accurate weighing.

In the Bessemer process as generally practised, the crude metal is entirely decarbonised, and is then brought back to the state of steel, by the addition thereto of a certain quantity of molten carburet of iron. In practice there are several sources of slight error in this system,

which are found generally to counteract each other to a great extent, but which sometimes may possibly alter the quality of the metal to an undesirable extent. Thus, suppose that five tons of pig-iron, constituting a charge, are weighed up for the melting furnace, this pig metal may consist of 94 per cent. of pure iron, combined with six of carbon and other matters, or there may be only 93 per cent. of iron present in the pig. The furnace-manager may loose five, or he may loose six, per cent. of the metal in melting it, a little metal may also be sometimes left in the bottom of the melting furnace and in the gutter, the loss in the converting process may also vary from one-half to 1 per cent. more or less than usual, and some half per cent. of metal may be accidentally thrown out of the vessel in the form of splashes; hence, although five tons were weighed up, the exact weight of the malleable iron resulting therefrom is more or less uncertain, and consequently the precise quantity of carburet of iron, to be added thereto, cannot be accurately ascertained. At first sight it would appear that 1 cwt. of metal more or less lost in several ways, and amounting in the aggregate to a quarter of a ton, in error of the supposed quantity, would seriously affect the quality of the steel; it however does not do so, for as no metal can be gained, we may assume that 500 cwt. in error is a maximum of unknown loss, if then we take a mean, and estimate the source of error at one-half that quantity, by no unfortunate combination of circumstances can there be more than an error of $2\frac{1}{2}$ cwt., or one-fortieth of the charge of 5 tons. Now in making a very mild steel, about 0·33 per cent. of carbon is required, say 1-300th part, thus the extreme difference in the quantity of carbon added to the metal would be $\frac{1}{12000}$ part too much or too little, a quantity quite recognisable as a chemical fact, but practically making no sensible change in the character or quality of the metal; should however the sources of error in the carburet of iron employed be equally great, and in the opposite direction, then a difference in quality to a small extent would show itself.

Now the first stage in the improvements before referred to, and which are intended to entirely remove these several sources of inequality, consists simply in accurately weighing the fluid malleable iron on a suitable weighing-machine, *after*, instead of *before*, these losses of metal have taken place, and thus removing in one minute, absolutely, every trace of the several sources of error above enumerated.

We next come to deal with the carburet of iron, which is to recarbonise this accurately-ascertained quantity of malleable iron. The carburet of iron is also subject to some of those small sources of quantitative error already described in reference to the pig iron, and also to some others in addition to them. In the first place, if we take four pigs of a carburet of iron, the quantity of carbon or manganese present may not be precisely alike in each pig, and in melting this metal, the quantity of carbon and manganese lost by oxydation in the furnace cannot be accurately estimated, and therefore although these numerous and minute sources of error are found practically to be neutralised by an average allowance of loss, it is nevertheless possible that they may all tend in one direction, in which case the difference in

quality of the metal would be more than is desired. To avoid every one of these sources of error in the carburetting metal, 100 tons of it may be melted in large quantities, and be then granulated in the form of shot, and be thoroughly mixed together. From this intimate admixture of granulated metal, every charge of 4 cwt. weighed up may be assumed to be of precisely the same quality. Now this shotted metal is not to be melted as heretofore, but heated only in an air-tight retort, where no manganese or carbon can possibly be lost, so that we have only to accurately weigh a proper quantity of this metal, and add it to the accurately ascertained weight of pure malleable iron, to obtain steel of a *pre-determined* quality, and if each of the 500 separate charges, which the 100 tons of shot will make, be added to 500 other charges of 5 tons of malleable iron, there will result 500 charges of *steel* weighing 25,000 *tons*, having an equality of temper or hardness, such as no other known process of steel-making has ever yet produced.

In manufacturing large masses of mild cast steel by the Bessemer process, nothing more is necessary than to melt some 20 or 30 tons of No. 1 hematite pig iron, in the ordinary reverberating furnace used for founding guns in cast iron, the furnaces when tapped, will run their contents into a converting vessel of some 10 feet in diameter, a powerful blast of atmospheric air is then to be driven vertically upwards through the fluid iron, for about 15 minutes, which will raise its temperature to the highest degree and convert it into malleable iron, which will then be in a state of perfect fusion; if then as much carburet of iron be added thereto as will give to the mixture about one-third of a per cent. of carbon, a very mild and tough cast steel will result, which may, after being stirred vigorously by a revolving agitator, be poured out into a mould, and thus, within half-an-hour of tapping the molten cast-iron from the melting furnace, a mass of some 25 or 30 tons of mild, tough, cast steel will have been produced, without weld or joint, and with a loss of only 15 per cent. of the pig iron employed in its production. Thus we have a means of rapidly and cheaply producing huge masses of malleable metal, having the peculiar characteristics which are found to be most desirable in a material to be used for ordnance. And here it may be as well to recall the fact to your notice, that the degree of heat required to extend and shape this mass under the hammer, or hydraulic press, is so far below the heat necessary for welding masses of iron together, that there is no danger whatever of bringing the steel so near the point of fusion as to produce the peculiar crystallised condition so difficult to avoid, and at the same time so destructive to forgings in wrought iron.

It has been found that large masses of cast steel, made by the Bessemer process, may be most advantageously treated under the hammer almost immediately after they have been cast, since at that time the interior of the mass is at a much higher temperature and consequently softer than the exterior of the mass, this allows the blow of the hammer to act efficiently on the central parts of the ingot, and thus remove the only difficulty that stood in the way of operating on large masses of cast steel. Before this important fact was proved, the invariable rule in Sheffield was to let every ingot get cold after

casting, and never to touch it under the hammer until the next day. Indeed the steel manufacturer went much further than this, for it was not uncommon to stack the ingots for months out in the weather to season them, like the old glass-maker used to do with his fritted materials, and never use them until a year after. When large masses of steel are heated after being allowed to get cold, the external parts are apt to become injured, and in all cases it will be found that the outside is always hotter and softer than the centre. It is therefore hopeless to attempt to properly reach and extend the hard centre of the forging, when it has a soft exterior to absorb the blow. It is difficult to determine whether this system of letting the ingot get cold before hammering is merely one of the deep-rooted prejudices of the trade, or a defect common to the old system of steel making; be this as it may, it is a fact, that more than one hundred pieces of ordnance have been made of Bessemer steel, and forged *hot* from the casting with perfect ease and success.

About a year ago a Mr. Thompson, of Bilston, obtained a patent for a new mode of making gun-barrels, of this material, by a series of very simple and efficient operations, examples of which he has kindly forwarded for your inspection. The steel is first hammered from the cast ingot into round bars, which are sawn into lengths. He then proceeds to punch a hole lengthwise through the mass, not by cutting out a portion of the metal, but by displacing the material. This is effected by using a blunt elliptical ended punch, which he drives through the mass of steel, under the steam-hammer. This is found to be a very severe test of the metal, a faulty piece being at once detected; indeed, it is probably a much more severe test of the metal than any that can be given at the proof-house. After the punching is effected, the pieces are drawn down a little under the hammer, and are then rolled between grooved rolls, which are provided with recesses, into which one end of the barrel is placed, so that the end is gradually shaped as required, the projecting part of the barrel being formed out of the solid, without any welding; he thus avoids the injury done to the metal by giving it a welding heat after the piece has received all the hammering required; these unwelded steel barrels can be produced at about 20 per cent. less cost than the best iron ones. Their extraordinary endurance under fire will be appreciated by reading the annexed report of their trial at the proof-house, Birmingham.

Trial of Two Steel Gun Barrels (Enfield Pattern), at the Proof-house, Birmingham.

Barrels made from Bessemer Steel by Thompson's Patent process.

Barrels, 1853 Infantry Pattern, 577 bore. Bullets used, 715 grains. Diameter, ·551· Length, 1·043. Ratio of length to diameter, 1·893.

Result of experiments:

1st round,	charge 205 grains,	7½ drachms powder,	1 bullet.
2nd round,	charge 224 grains,	8¼ drachms powder,	1 bullet.
3rd round,	"	"	2 bullets.
4th round,	"	"	3 bullets.

5th round,	charge 224 grains,	8¼ drachms powder,	4 bullets.
6th round,	"	"	5 bullets.

The barrels were now examined and found intact.

7th round,	charge 224 grains,	8¼ drachms powder,	6 bullets.
8th round,	"	"	7 bullets.
9th round,	"	"	8 bullets.
10th round,	"	"	9 bullets.
11th round,	"	"	10 bullets.
12th round,	"	"	11 bullets.
13th round,	"	"	12 bullets.
14th round,	"	"	13 bullets.
15th round,	"	"	14 bullets.
16th round,	"	"	15 bullets.

Barrels found intact.

17th round, charge 224 grains, 8¼ drachms powder, 16 bullets.

The firing was now continued with one barrel only, the nipple having been blown out of the other, which, still retaining its charge of 16 bullets, remained intact.

18th round,	charge increased to	269 grains,	9¾ drachms powder,		17 bullets.
19th round,	"	"	"	"	18 bullets.
*20th round,	"	413 grains,	15 "	"	and 25 bullets.

Length of each bullet 1·043.

The barrel was then examined and found intact.—Further test was deemed unnecessary.

Proved by Mr. Samuel Hart, Assistant Proof-Master, *in the presence of Ezra Millward, Esq., Proof-Master at Birmingham, December 23rd, 1863.

These results may be taken as a fair indication of the nature of the Bessemer mild-cast steel, and of its applicability for ordnance.

However important a tough malleable metal may be for the manufacture of guns, it is not less so for projectiles intended to be employed against armour-plates or forts.

It is now more than three years since the writer obtained a patent for a machine for rolling cast steel spherical shot, under the full conviction that the time would arrive when the value of cast steel spherical projectiles would be appreciated.

The eight-inch spherical shot exhibited, are the first products of the first rolling-mill ever erected for the manufacture of spherical shot. A finishing mill to give them the last touch, would polish and improve the surface, and give extreme accuracy of guage.

Some few trials have already been made of the Bessemer steel shot with more or less success. A singular misapprehension appears, however, to prevail in reference to them. Some of the trial shot sent in by the manufacturers of Bessemer steel, were said to be too mild or soft for the purpose, and consequently not equal in penetrative power to some shots made of a harder temper, by the old and expensive mode of making steel in pots. Now the simple fact is, that nearly all the Bessemer steel now manufactured is of a very soft or mild quality, because a mild tough metal is indispensable when employed for the numerous engineering purposes to which that metal is now applied.

Thus it appears that a general impression prevails that Bessemer steel is naturally a soft, tough metal, but never hard or highly carbonised like other steel. This is one of those popular errors that

grow up unperceived, and for which there is not the shadow of a foundation, for there is not the slightest difficulty in carburetting Bessemer steel to an extent wholly impracticable with ordinary cemented steel. The Bessemer metal is made with equal facility, of any desired temper from the hardest and most refractory quality, by a series of almost endless gradations (at the will of the operator), down to the mildest cast steel, and beyond this point again to wholly decarbonised malleable iron, possessing nearly the softness of copper; it will be readily understood with what extreme ease and certainty this may be accomplished, if we consider that a given weight of wholly decarbonised iron requires 500 lbs. weight of a carburet of iron to be used therewith to produce the hardest steel, it is clear that 490 lbs. will make it one degree softer, and so on. By such marked differences as 10 lbs. at each step, we should have fifty tempers of steel instead of about ten as found in commerce.

The CHAIRMAN: I am sure the meeting will agree with me that our thanks are due to Mr. Bessemer for the very interesting paper he has read upon the application of his very original and economical method of making steel for the manufacture of ordnance. Seeing the excellent diagrams that Mr. Bessemer has exhibited showing the method he pursues in making steel, I think it would be interesting to the members present if he would be kind enough to explain the use of the vessels.

Mr. BESSEMER: The vessel AA, Plate XXV, used for the conversion of crude iron into steel by our process is mounted on axes, and is supported between two cast-iron frames C, the axes are so placed as to balance as nearly as possible its contents. The further side F is generally connected with some hydraulic apparatus, for the purpose of communicating a sufficient amount of power to turn it round with facility. A vessel of this kind weighs something like ten or eleven tons, and it holds five tons of metal, so that hand labour for turning it would be impossible. Again, the different speeds at which it must be moved as it approaches the pouring point, prevent the application of ordinary machinery which moves with great regularity, and you would, therefore, pour out a very irregular quantity of metal. The vessel is lined with a very refractory material. The lining, when it is perfectly dry and baked hard, will stand something like eighty or a hundred successive charges without being worn out. When the vessel has been heated inside by a little preparatory fuel (the residue of which is turned out), it is placed in the position shown in the first diagram (see Plate, Fig. 1), and a spout, B, conducts into it about five tons of molten pig iron. Immediately the molten iron has been poured in, the spout is removed, and the hydraulic apparatus is put in operation. It quickly turns the vessel round from this position into the one shown in the second diagram, Fig. 2. We have a reservoir of air under pressure, and a large air-forcing apparatus which drives air into this lower chamber or tuyre-box as it is called. There are several clay pipes divided into ten or twelve passages, which project into the interior of the vessel through the lining. During the time of filling the vessel there is no air blown through these pipes, nor can the metal enter those holes because they are placed above its level. That enables us to pour in the metal quietly without interfering with the operation. Immediately we want to commence the converting process in this vessel, we turn on the air; and as the vessel is moved round on its axis the metal occupies the lower position, and would immediately run down into these apertures only that the pressure of air is always kept greater than the pressure of the column of metal at that height, generally twice the pressure is employed. The effect of the air now going through under a pressure of some 18 lb. or 20 lb., is, that the air escaping from that pressure into the fluid separates itself into millions of little globules. I have blown air under similar conditions into a large glass tank of water in order to view the operation; and if we assume that the same condition takes place in fluid iron we may safely say that countless millions of bubbles are produced from one of these jets. It is very much like drawing the cork of a champagne

BESSEMER STEEL

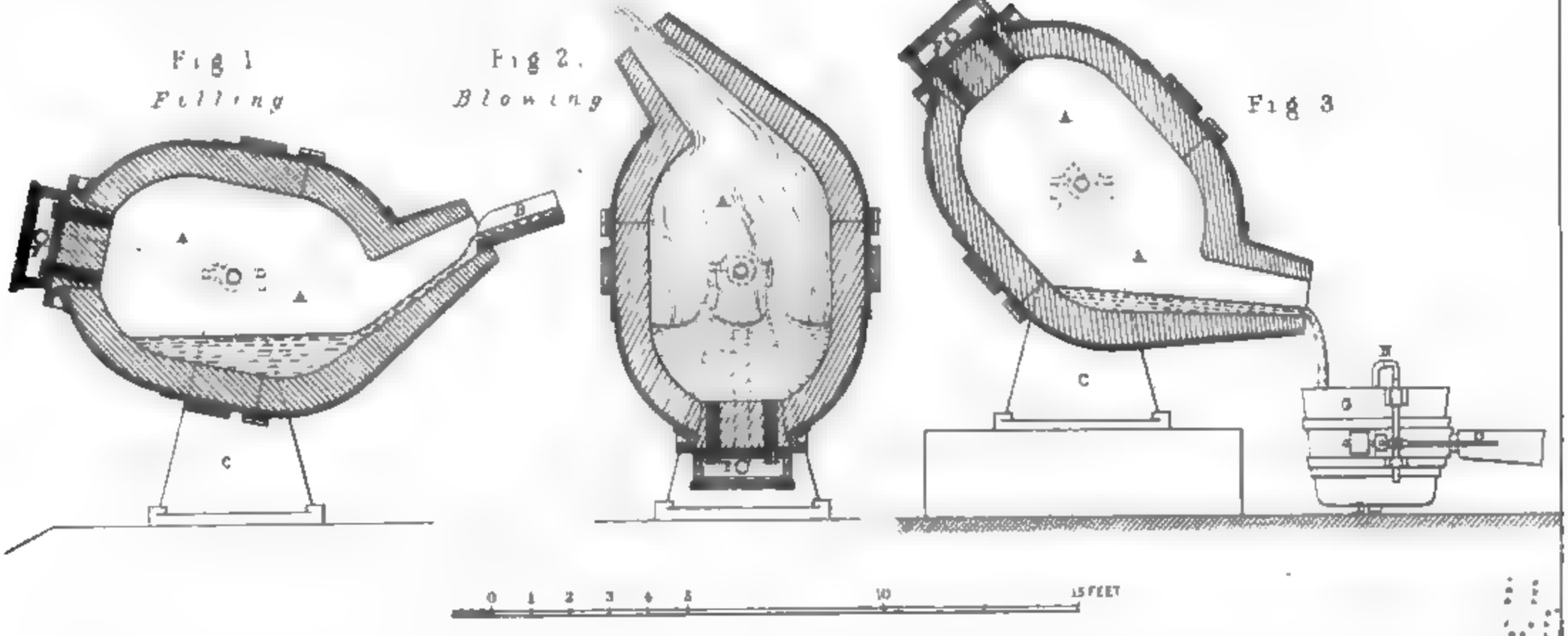
Positions of Converting Vessel in Filling and Blowing

Pouring out the Steel

Fig 1
Filling

Fig 2.
Blowing

Fig 3



J K Jobbins

bottle; the fixed air through the mass shows itself at every point. Here we have also these countless thousands of bubbles flowing upwards with great rapidity through the great mass of metal. As these escapes of air are taking place from something like ten tuyeres with twelve holes in each, we have one hundred and twenty jets, each producing those thousands of little globules. Upon the atmospheric air entering into the fluid metal, the oxygen of the atmosphere is necessarily brought into contact with the carbon of the pig iron. The result is a union of the carbon of the metal and the oxygen of the atmosphere, so that every one of these little air bubbles becomes a fire bubble. And as there is nothing between the fire so generated and the metal that surrounds the bubble and that forms the wall of each little cell or bubble, the heat so produced is absorbed by the iron, and as these bubbles are continuously formed at this great speed, an immense surface is exposed to the action of these little fire globules. On floating to the surface they entirely fill the vessel, which is eleven feet in height. And not only so, for they are projected out of an aperture thirty inches in diameter, and for some ten or fifteen feet in length we have a tremendous roaring flame, as white as snow and as bright as the sun, which is simply the accumulation of the fire produced from these globules. The result of thus highly heating the metal is, that instead of getting solid in its transition from pig iron into malleable iron, the temperature is kept up and we obtain an entirely new product, viz., malleable iron in large quantities in a state of perfect fluidity. A very singular thing takes place in the first stage of this process, which I may mention. Pig iron in addition to carbon invariably contains a notable amount of silicium. That silicium is a great enemy in iron; it is one of the difficulties of the ordinary manufacture. The affinity of oxygen for silicium is so great that it immediately seizes upon the silicium at first. Although I have described to you what is the action upon carbon, I should have told you, that before the carbon is touched at all, the oxygen of the air seizes on the silicium, which is burnt out with very little sign of flame, and only a few sparks from the iron, and with no visible increase of temperature until three or four minutes after blowing, when the silicium is all gone, the oxygen then takes the next substance in affinity, which is the carbon. In the early stages of this process, by the indications of the flame, we were enabled to judge with tolerable correctness when a proper amount of carbon had been taken out, so as to leave enough to constitute steel of a given quality. That was a process of the eye, requiring, like the old puddling process, many years of practice, and involving a great deal of uncertainty. The next step after the reduction of the metal to pure malleable iron, is the addition to it of a certain quantity of carburetted iron, by which the whole is brought back to steel of a known quality. When that has been done, the vessel is further turned on its axis until it assumes the position shown in the third diagram, Fig. 3. The stream of melting metal falling into a casting ladle G is shown in this diagram. The ladle is brought round on the arm of a crane and by means of a valve L in the bottom of the ladle actuated by a rod N which passes down the interior of the ladle, and is provided with a lever O so that a man who follows the ladle round lifts the handle, and allows a certain quantity of the metal to flow into the moulds, by which means any *scoria* floating on the surface does not form part of the ingot. Thus, we have here, what is very unusual in engineering operations, viz., a cone valve letting out molten malleable iron. These valves cost very little, but they can only be used once.

The CHAIRMAN: I understand you invariably procure your steel by purifying iron completely, and then introducing a quantity of carburetted iron of known composition?

Mr. BESSEMER: This is the mode practised in England. It is not so in Sweden. There is a very successful manufacturer of steel in Sweden who has made a beautiful quality of metal from high class ores by charcoal. He first saw the process in England, at the time when we had not adopted the re-carbonising of it at the end of the process. He went home to his own country to carry out a system he had seen so far successful with us; and by great attention to the subject, he has succeeded so well in watching the indications of the flame, and in taking time of the process (which is generally very regular, scarcely ever varying one minute in point of time), that he has been enabled to produce all the qualities of steel he requires, without re-

carbonising at all. The mode of regulating the temper or degree of hardness of the steel by the addition of molten carburet of iron at the end of the blowing process, was described in the first patent which I obtained for making steel by forcing air into crude iron, but was not practiced in the early working of the process.

The CHAIRMAN: We have several specimens of Swedish iron and steel in our Museum.

Mr. BESSEMER: There are some very excellent specimens in the Museum.

Mr. ASTON: Mr. Bessemer would oblige the members by giving a little more information with reference to the guns he spoke of, as having been made of his metal. I think he mentioned there were a hundred or more that have been made of the Bessemer steel. If he would kindly tell us something with reference to the weights and calibres of these guns, the information would be very valuable. I would also ask what steam-hammers are used for hammering the mass after it has been cast; and whether Mr. Bessemer has encountered difficulties in the way of hammering the mass, so as to ensure its being homogeneous—supposing the metal to be close and sound after it has been cast; whether during the process of hammering he finds that any portion of the mass deteriorates, whether some parts undergo any change which causes them to lose that uniform quality which I was very glad to hear he was able to impart to his metal? There is another point to which I am sure Mr. Bessemer's attention has been drawn, and that is the very great advantage which must necessarily arise from the use of the metal that he spoke of in all penetration trials against the armour plates, which will no doubt henceforth almost always form a portion of the structure in our navy. It is obvious that projectiles of steel must be used against armour-plates, and I should wish to know if Mr. Bessemer manufactures any particular quality of steel that he finds advisable to employ for penetration experiments. Different qualities of steel are employed by engineers according to the different purposes for which they employ it. No doubt for the crank axle of a steam-engine you would not employ the same quality of steel that you would for a shot that you wanted to send through a 4½-inch plate. If Mr. Bessemer can give us more precise information upon these points, I am sure the meeting will feel obliged.

Mr. BESSEMER: With reference to the first question the gentleman has asked, I am quite unable to tell him anything about the guns after they left my place. We have a shrewd suspicion (as they were delivered at Liverpool) that they went across the Atlantic. Upon that point I am unable to state anything further. With regard to the other questions, I am quite able to give the information he requires. In the forging of these guns, we have never found any difficulty in reaching the centre of the gun with the forging; and, I believe, entirely from the fact of our always using a large mass of steel in its hot state from the casting. When the fluid steel is poured into a cast-iron mould of some 2 or 3 inches in thickness, the quantity of heat rapidly absorbed from the exterior of the casting is such as to leave the outside rather too cool for forging, while the interior remains in almost a fluid state. Indeed, we have sometimes accidentally removed them from the moulds while the interior has been so hot that in laying them sideways they have poured out a little fluid from the interior. We find, for example, that when a piece of metal that weighs a ton, after it has been poured into the mould for about eighteen or twenty minutes, will have lost a sufficient quantity of heat to render it safe for removal. If you then put it into a furnace and warm the exterior a little, and allow the interior to lose more of its heat, at the end of twenty minutes in practice we find the ingot is in a right state for working. If you were to cut the ingot through with a cutter, you would find the inside of it at a white heat, a blow upon such a mass as that being received on the harder metal on the outside, and which becomes progressingly softer and softer as it approaches the centre, will transmit nearly the whole of its force to the central part of the mass, and it will not stretch most on the exterior as a bar ordinarily heated always does. That is one of the difficulties of forging that we get over. If you heat a large mass that has once been cold, you cannot get the interior up to the same heat as the exterior, the result is an imperfect forging. One rule we observe is this, the breech end of a gun, after the forging is complete, is drawn by a steam hammer into a bar 2 inches thick and 3 inches wide. That size is accidentally chosen, but if a bar so large as that will bend double when cold, it is certain that it is of good quality. A bar

2 inches thick and 3 inches wide can never be bent double if the metal has been burned. If we find it defective in this respect we do not send out the gun.

Captain SELWYN: What are the calibres of those guns?

Mr. BESSEMER: I think they have been guns of 12lb., 18lb., and 24lb. We have not bored them; we have merely sent out the blocks.

Admiral HALSTED: Are they for rifled guns?

Mr. BESSEMER: Yes, for rifled guns.

Mr. ASTON: What is the weight of the steam hammer?

Mr. BESSEMER: Those were forged with a steam hammer of two and a-half tons; a steam hammer of larger weight would have been better.

Admiral HALSTED: What would have been the weight of a bar?

Mr. BESSEMER: From 1 ton to 30 cwt. There is one question I did not answer about the quality of shot for penetration. That is a point in which we have had no experience. Like everything else it wants experience before we can speak with any certainty. We have hitherto made steel for other purposes of a mild, soft character; because it is used for engineering purposes, and any approach to brittleness is fatal. I know that some of that soft metal has been made into shot and fired at the armour plates. It has become a question whether that mild quality of steel is hard enough to do its duty properly. There is a point between the flattening up of a shot and the degree of brittleness that will make it fly into pieces; this is a nice point which practice alone can give. In my material there is no difficulty in arriving at any of these results which are desired, inasmuch as the metal used for carburation is now weighed and measured. As I said just now, if instead of adding 500 lb. to make a given quality, you add 490 lb., you have a less carburetted metal; and if you employ 480 lb., or 460 lb., and so on, you can by degrees get it so much softer. All that will be required, is to know the service for which they are to be used, and a dozen different tempers may be made as easily as one. A few shots of each quality can be tried against the material they are desired to penetrate; and those shot which stand the best, will give the necessary indication of the degree of softness or hardness that is required.

Admiral HALSTED: You do not show the application of the carburetted iron.

Mr. BESSEMER: The mode in which it is introduced after the metal has been converted into soft malleable iron is this: the vessel is turned again into the position shown in the first diagram, and at the moment it assumes this position, the air is shut off from tuyere box; and the carburet of iron is run in by the same spout that was originally employed to run in the pig iron in a molten state.

Mr. ASTON: The information which Mr. Bessemer has given us is of great value to all manufacturers of guns, but I should be glad to know how he is able to ensure that the amount of carbon which he imparts to his carburetted iron is retained by the mass, and that no portion of it is destroyed. Does he make any allowance for the combustion of some portion of the carbon he puts in, by mixing an extra quantity, so as to provide for waste in case it should happen? The fact that a uniform quality of steel can be made so as to be applicable to the manufacture of ordnance is a fact which I am sure all will be extremely desirous of believing, and desirous of seeing put into practical operation. That steel is used to a very large extent there is no doubt whatever; but it is well known that it is used at very great cost. If Mr. Bessemer by his process is able to reduce that cost, so as to bring the use of steel more largely within the means of the manufacturers of guns, he will assist them very materially, and the country at large will derive very great benefit, inasmuch as they will have cheap steel guns, instead of steel guns that are costly. With reference to the guns now being tried at Shoeburyness, both those of Sir William Armstrong and those of Mr. Whitworth have their inner tubes made of the metal whose use Mr. Bessemer advocates, namely, cast steel.

Mr. BESSEMER: With reference to the loss of carbon, in the ordinary way in which the process is now carried out, the fluid carburetted iron is poured in as I have described, and there we find we are subject to a little irregularity as to the quantity itself. In the first instance, we are not quite certain, in melting carburetted iron how much of the carbon in it may have disappeared in the process. That is our chief difficulty. Again, when a large quantity of carburet of iron is poured into fluid

malleable iron, a certain quantity of carbon always flies off, as we observe by the flame arising from the surface of the metal. But in the plan I now propose to use in all these cases, where extreme nicety is required in the quality of the metal, there will be none of these losses in the melting furnace, inasmuch as our carburet of iron will not be melted at all, but the metal will be heated in the form of shot. Those shot from having been mixed in great quantities will be absolutely uniform in quality. That is to say, taking a charge of three or four hundred weight of shot, there will not be less than from eight hundred thousand to a million separate pieces, and those separate pieces having been made of as uniform quality as possible, for all practical purposes the result will always be absolutely the same. In the addition of this red-hot shotted metal to the fluid malleable iron, none of the carbon flies off, in the same way as when using a large bulk of the fluid carburetted iron.

Admiral HALSTED: May I ask the meaning of the word shot?

Mr. BESSEMER: The carburetted iron in a fluid state is poured into water and the result is the formation of fine granules or shot, like the lead shot used for shooting birds.

The CHAIRMAN: Is there much difficulty in obtaining this carburetted iron? I suppose it is necessary it should contain nothing else but iron and carbon. Is there not some difficulty in obtaining such iron?

Mr. BESSEMER: We get a very pure charcoal iron for that purpose, and the amount of other matters or impurities present, except manganese, is so small as practically not to interfere with the purity of the metal.

Captain JASPER SELWYN, R.N.: I am sure Mr. Bessemer will excuse another member of the Institution asking a question. We have many inquiring minds, and as the results affect us most materially, I think I may beg his indulgence for a moment. I do not think we have quite arrived at a conclusion as to what the relative cost of steel thus prepared is to the cost of ordinary steel. It would be most useful if we had some accurate comparison. So many different opinions are entertained upon the point, so many different statements have been made—I will not say by parties interested, but by parties who have not quite interested themselves enough in the subject—that it is very desirable that any fallacies existing on the subject should be settled at once, by reference to the source from which we can alone get correct information. I do not speak of the comparative cost of making the steel under the system of licences, which I hope may long continue to yield profit to Mr. Bessemer, but of the way in which it could be made with the view to large operations by the Government. That I think would be a most valuable point to make clear. I think gentlemen will join with me in admiring the splendid illustration which this lecture has conveyed to us of the value of scientific research. Mr. Bessemer would in vain have sought for the conclusions which have led him to such successful results, had he not had the labours of chemists in their studies for centuries past, to give him the constituent parts of the matters with which he has to deal. Therefore, let us never undervalue the labours of the old man who bends his withered frame over a furnace, it may be in search of the philosopher's stone, but who yet gives many results to the world, which, centuries after his death, become of the utmost value to mankind.

Mr. BESSEMER: As regards the cost of production of this metal, it will be interesting perhaps to you to know, that at the time when Colonel Wilmot was in power at Woolwich, just before Sir William Armstrong went there, I had interested him very much in this manufacture. Indeed I should rather say his own intelligence had so pointed out to him that something was to be done more than could be done by the old mode, that he rather sought me out. He expressed himself very much delighted with the prospect which my process seemed to offer of giving a better description of ordnance at Woolwich than they had before. They had not been so successful in cast-iron guns as they had hoped to be, and Colonel Wilmot was most desirous that their valuable foundry should be turned to the greatest possible account by the Government. On more than one occasion he said to me, "We have the space, we have the buildings, we have the furnaces, and we have the casting pits and the moulds; but the cast-iron we pour into them is not good enough for a gun. Why should we not first blow that metal with a little air, and then put it into our moulds, and then we should have a superior material." So strongly was he

imbued with that idea, that after visiting my works at Sheffield, he communicated to the authorities at Woolwich what he had seen; and on more than one occasion I had interviews with him on the subject. Indeed, I went so far as to give a written contract to the late Lord Herbert, who was then at the head of affairs at Woolwich. In that contract I undertook for £5,000 to erect enough machinery on my principle to produce two hundred tons per week of cast steel blocks for the Government, and my estimate was that cast steel blocks poured into their own moulds would cost £7 per ton.* Lord Herbert said he would refer the question to Sir William Armstrong, and I never heard anything more about it. With regard to armour-plates, as far as my opinion goes, Bessemer steel is totally unfitted for the purpose. It is very well to say "there is nothing like leather," but sometimes leather is not good. I believe that in the condition of steel we shall never produce an armour-plate that will stand even cast-iron shot. I believe that an armour-plate requires to be exceedingly soft and tough, and not hard like steel. In fact, the general characteristics of steel wholly unfit it for armour-plates. I believe also that a considerable improvement in armour-plates may be made by in part carrying out my process of steel making; that is, if we reduce cast-iron to the state of very soft pure malleable iron, and do not recarbonise it, we shall then have a metal the toughness of which is almost beyond belief. Indeed, excepting the very best copper, I do not know any metal that is equal to it in toughness, and its softness approaches so near to copper, that it may fairly be taken out of the category of common iron. I believe that that metal may be made into armour-plates with great advantage. But in order to get that excessive toughness which you require in the armour-plates, if you cast a large mass a granular structure will run through it, but if you roll it into thin plates and weld them together, the structure will be much changed, and we shall then have separate layers of toughened metal. If we take a large granular mass of steel and compress it from one foot square to six inches square, we shall find the structure altered very little indeed. But if you bring it into a much smaller space, it appears that the crystals get elongated, and that their cohesion is very much increased. Now I think that that increased strength and toughness can be best got by reducing the metal to small sections; but I think the ordinary mode of welding renders it so exceedingly imperfect that we should try and improve in that direction; and it is in that direction I am attempting to go. Every one who has seen the experiments on armour-plates will have observed that when the shot strikes a plate and penetrates to a certain extent, large masses generally fly off from the back. When these large masses tear off we always get a large portion of the surface separated in the direction of the weld of the plate, but if welding ever took place thoroughly, that separation would never take place.

Admiral HALSTED: It never has been done.

Mr. BESSEMER: It never has been done, and never can be, on the system by which welding is now attempted. The mode by which I think welding may be effected is this. Having rolled a certain number of plates, I would put them in diluted acid in the same way that you prepare plates for tinning, or galvanising, by which means the thick coat of oxide which they acquire in rolling is separated from the metal. We have then a clean surface of metal to act upon. When they are taken out of this pickle-bath, I would put upon them a sort of wash, that is, any easy melting flux, silica being one of the constituents. If you then put a number of plates so coated together, and get up a welding heat upon them, a good weld may be made, for there is no oxidised surface to begin with, and the surface is so coated and protected from the contact of atmospheric air that they acquire no new coat of oxide while being heated up. Again, we have between all these surfaces (by the time the welding heat is arrived at) a perfectly fluid matter, which under the pressure of the rolls will come out from between these surfaces; and as in the act of soldering, you allow metal to come in contact with metal, and a much more perfect union takes place than is possible when there is a hard dry scale of oxide between the surfaces of the several plates. How far this may produce an absolute junction of the metals

* This was in 1859, when the pig iron employed was nearly £2 per ton cheaper than at present.—H.B.

it is difficult to say; but I think it will produce it much more effectually than at present.

The CHAIRMAN: Just on the same principle that borax is used for soldering.

Mr. BESSEMER: Exactly.

Mr. BARRASS: Is it possible to cast a gun with a core?

Mr. BESSEMER: As far as my experience goes the casting of steel with a core is an exceedingly difficult matter. There are very few materials known to us that will stand the excessive heat of melted steel without going into a state of fusion Ordinary sand fuses rapidly in the presence of steel in a melted state; and whenever the core commences to fuse on its surface, the gases generated can never pass out through the pores of the mould, but they pass into the metal, which becomes imperfect.

Captain SCOTT, R.N.: Will you allow me to ask what is the size of the guns that the Prussians have ordered?

Mr. BESSEMER: I am not at all aware.

Mr. D. LONGSDON: Perhaps I may be allowed to supply that information, being the brother of Mr. Krupp's agent in this country. The guns ordered of Mr. Krupp by the Prussian Goverment have been 7, 9, and 11 inch.

A MEMBER: Will the gentleman allow me to ask whether they are cast solid, or hollow?

Mr. LONGSDON: Solid, afterwards hammered, and then bored.

A MEMBER: We hear that the Americans cast guns of heavy calibre with a core, and in order to avoid what Mr. Bessemer mentioned, the melting of the core, they have an ingenious plan of allowing water to percolate through to keep it in a cool state. If that can be done, I wish to ask Mr. Bessemer whether he thinks it would be desirable?

Mr. BESSEMER: I think that the amount of forging which is necessary on a piece of cast-steel to develope its full strength is such, that it would be impossible in a gun cast with a core, to give it the amount of working that is necessary to develope its proper strength. The forging of a hollow gun would be very unsatisfactory in the interior; we could not introduce the mandril into it; for, if it closed upon it, the mandril could not be got out again.

Captain SCOTT: I can supply some information that may complete this paper. You have mentioned about steel for guns. There are steel guns in the Arsenal which were supplied by Krupp. There is a 110-pounder, a 40-pounder, a 25-pounder of his, and there is also a gun supplied by Naylor Vickers. The whole of these guns went through the one hundred rounds with increasing cylinders, and were found to be perfect afterwards, with not a single crack to be seen in them. The 25-pounder of Krupp, and the 25-pounder of Vickers were then fired with double charges. They are still uninjured, and may be seen by anybody who wishes to look at them. No other guns have ever stood such a proof before. All the coil guns that have been similarly tested have been more or less injured.

Admiral HALSTED: To what size have you yet produced your ingots?

Mr. BESSEMER: At our own works we have only produced ingots up to six tons in weight.

Admiral HALSTED: What diameter would that be?

Mr. BESSEMER: That would make one of our largest ship guns, I suppose, about five tons when finished. We are making apparatus, however, for one firm that will produce masses twenty tons in weight: indeed we should have no difficulty in producing fifty tons.

Mr. ASTON: Will they put down steam hammers in proportion?

Mr. BESSEMER: Certainly.

Mr. ASTON: I believe Mr. Krupp is using steam hammers of one hundred tons.

Mr. BESSEMER: He is using very large ones; I do not know the weight.

Mr. ASTON: He has had several of fifty tons.

Mr. LONGSDON: The largest steam hammer that Mr. Krupp is using is fifty tons, with a fall of 10 feet. He is now putting down to assist that hammer, which has so much to do in consequence of recent orders, two hammers of thirty tons each.

LECTURE.

Friday, May 13th, 1864.

GENERAL H.R.H. THE PRINCE OF WALES, K.G., K.S.I., &c., &c., Vice-Patron of the Institution, in the Chair.

RAILWAYS STRATEGICALLY CONSIDERED.

By Captain H. W. TYLER, R.E., Railway Department, Board of Trade.

AN eminent soldier and author of the last century—Marshal Saxe—asserted that legs were of more value than arms in war. Other writers express the same idea in saying that the whole secret of war consists in marching; and the Archduke Charles proves the truth of it by showing that certain battles are won by successful strategy before they are fought. Now strategy is simply the art of moving military forces to the best advantage on a theatre of war; and the objects to be attained in the practice of it during a campaign (as well as in the practice of tactics during a battle) are (1) to be superior at the proper time and at the decisive point, and (2) to threaten the communications of an enemy without exposing your own. Setting political considerations aside, war is from beginning to end a question of communications. The Romans, when they subjugated a country, set to work at once to make roads through it, and those roads remain to the present day. In now forming the plan of a campaign, the main points to be considered are the direction in which and the lines by which the forces shall be moved. In carrying it out, the principal care of a commander is to prepare for victory by employing the means of communication or transport at his disposal to the best advantage, and massing his forces on the decisive points. The position of those so-called decisive points depends upon the communications of the country. The nature of ground, the position of rivers, mountains, marshes, is chiefly important as affecting the progress of the troops, and the way in which their communications can be secured. The manœuvring which sometimes precedes an engagement is effected with a view, either to cut off a portion of the enemy before the remainder can come up, or to obtain a position from which his communications may be threatened; and a mere threat of this sort is frequently sufficient to force an enemy to retreat without fighting. During a battle, on a scale of whatever magnitude, the victor looks mainly to the communications of his enemy, the vanquished to his own. And in the course of a pursuit, the object of the victor is still to intercept his

foe's communications, and thus to cut him off from his base of operations.

Communications being thus, as it were, of supreme importance in warfare, and the success of campaigns depending mainly upon their being used to the greatest advantage, it is a matter of the highest interest to all military students to study the effect of railways upon the various operations of war, and to profit, as far as possible, by the experience which has been afforded in other countries on the subject.

It is not yet forty years since passenger railways came into use, and there were at the end of last year 12,299 miles of railway open for traffic in this country alone,—in which 400 miles a-year are still being constructed. In round numbers there are about 113,600 miles of railway in the world, of which 53,000 are in Europe, 52,000 are in North America, 6,000 (principally in British India) are in Asia, 1,800 are in South America, 600 are in Africa, and 200 are in Australia. They will no doubt continue to increase for a length of time with great rapidity; and the more they spread over a country, the more important they become in a military sense. The tendency of railways in every country is to radiate from certain centres of traffic and commerce. The trunk lines are first filled in, then secondary lines and cross lines, and, finally, the means of communication between, first, the principal, and, secondly, the inferior places become multiplied. It is impossible now to lay out any long line of railway in this country which does not compete more or less with existing lines. The junctions at which some of these lines meet must become strategic points of the greatest importance to the defence of every country—points on which an invader would at once seize, and the loss of which would very much hamper the operations of the defenders. Looking at the map of England, such points are at once apparent. An enemy landing on the south coast would naturally regard the junctions at Brighton and Lewes, of the line from London with the South Coast Railway, as points of primary importance, and Canterbury, Ashford, and Hastings on the one side of it, as well as Havant (on the north of Portsmouth) and Bishopstoke (on the north of Southampton) on the other, are also places of great importance for the same reason, namely, that the main lines out of London join the coast lines at those points.

Of these junctions, Canterbury and Ashford derive protection from the fortified position of Dover, and Havant and Bishopstoke from that of Portsmouth; and it is evidently not necessary, under existing circumstances, to throw up works in anticipation for the defence of the remainder, as it might be if our coasts were more accessible, our fleets less strong, and our volunteers less efficient. But with our *vital points* placed, as they are (except Spithead, the most important of them all), in a respectable position of defence, and with 150,000 gallant volunteers ready to assist the regular forces in manning our forts, as well as in more active operations, we need be under no apprehension for the safety of the country. I would, however, while on this subject, say a few words in regard to the defence of our coasts. There is a very general opinion—and confirmation has been prominently given to it by a gallant naval officer in this theatre—that our

system of coast railways might, if the connection were completed at certain points, be relied upon for conveying troops to prevent the landing of any hostile force. I need hardly say that any invasion of this country would be attempted in great force, and that the portion of the coast which would require to be specially guarded lies between Portsmouth and the Thames. The enemy might be expected in several divisions, and at different points, and our great object would be to have four or five thousand men (including a strong force of artillery) *on the spot*, ready to fire into their boats as they approached the shore, supported by the fire of their larger vessels. If they were to land unopposed, or inadequately opposed, then we should have lost the best opportunity for attacking them at the most critical period of their first operation,—as they were approaching the shore, leaving the boats, and forming on the beach. Now the coast railway cannot follow all the sinuosities of the coast, and is in places several miles from it; and during the time that would be occupied by a body of troops in marching (on being warned by telegraph) to the railway, in embarking upon it in successive trains, in performing their railway journey, in disembarking from the trains, and in marching to the spot at which a feint had been made, or at which their presence was really required,—these operations having taken all the longer for want, perhaps, of platform and siding accommodation at the particular points of the railway employed,—the enemy would have reached the shore, and would have taken up a position in force to cover the landing of more troops.

In this, as in all other cases, railways are comparatively of little use for short distances, or where troops have to march any great distances to and from them. The length of time occupied in preparing the trains and embarking the troops (including cavalry and artillery) is considerable as compared with that consumed on the journey. On the other hand, 20 or 30 extra miles in a railway journey, when the troops are once embarked, is only a question of an hour's travelling. It is obviously in the case of long journeys, in which the troops can perform in an hour, and without fatigue, what would otherwise be a hard day's march, that they are of most service.

If we were obliged to make serious preparations against an invasion, we should do well, for these reasons, not to rely upon coast railways alone, but to form camps in the necessary localities round the coast, and to organize movable brigades,* able to move independently of the railways, or to take advantage of them, as might be required.

In considering the relative importance of roads, rivers, and railways, we must reduce them to the common measure of time. In military operations, victory is a question of days, or hours, or sometimes even of minutes, in the movement of troops, when the forces are on anything like an equality. The time that will be required to march a certain number of troops to a given spot having been calculated, and their support being a matter of vital importance to the contemplated

* Such, for instance, as that which was so efficiently equipped and instructed at Shorncliffe in 1804, under (Sir John) Moore, and which afterwards became so celebrated as part of the Light Division in the Peninsula War.

operations, delay may ensure defeat, as punctuality may render success comparatively certain. Those were anxious moments during which Blucher was floundering through the mud with his gallant troops on his way towards the field of Waterloo. But the computation must be separately made for each road, each railway, or each river, according to their respective qualities and means of accommodation, and that irrespective of distance. So many hours, rather than so many miles, from A to B—from any one point to any other point on the chart—with such and such chances of obstruction, impediment, or delay, is the result at which any one arranging the plan of a campaign wishes to arrive, and on which he must base all his projects.

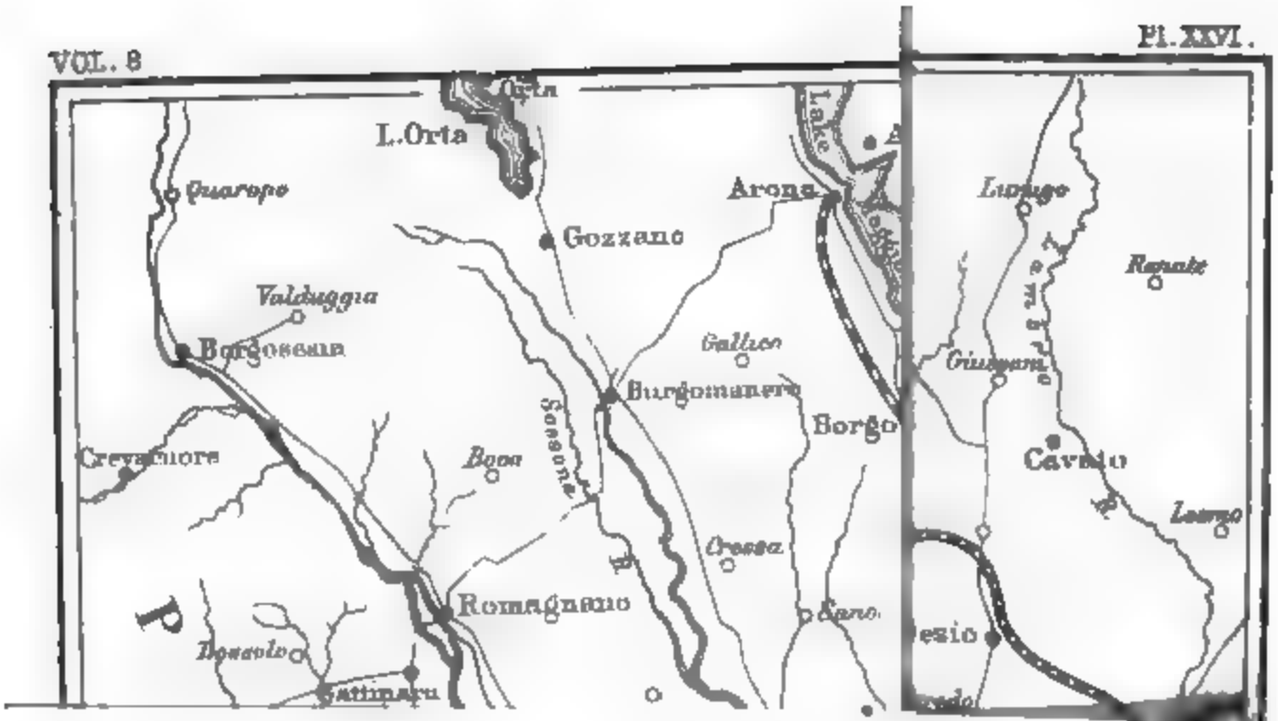
On a well made railway, in good order, with two lines of rails, the number of troops that can be despatched with their stores and ammunition, is only limited by the number of vehicles available, and the delay in forming, loading, and despatching the trains at one point, and unloading and returning them from the other. There are about 7 locomotive engines, 21 carriages, and 140 trucks or waggons, for every 10 miles of railway on the principal metropolitan lines of this country. But the rolling stock of any one line may be employed upon any other line, as is frequently done for purposes of excursion traffic, when the guage is the same. In the event, therefore, of hostile invasion, or in any case in which a partial interruption of the ordinary traffic would be temporarily justifiable, the supply of locomotive power, and of vehicles for the transport of men, horses, guns, and ammunition, would be practically unlimited.

A field battery of artillery will take 45 minutes to load, and 45 minutes to unload, and will require, on the narrow guage lines of this country, six carriages, 20 trucks and break-vans, and 57 horse-boxes, making altogether 83 vehicles. These might be conveyed along a tolerably level line in two trains, weighing, besides the engines and tenders, about 250 tons each. A regiment of infantry,* requiring 40 vehicles, might in like manner be taken in one train. And a regiment of cavalry (at 400 horses and 500 men) with baggage and forage, requiring 135 horse-boxes, and 25 other vehicles, might be taken in four trains. When loading banks are not available, or are insufficient, temporary platforms are required for embarking horses and guns, and the time which would be occupied depends upon the amount of accommodation provided.

An army division consisting of two brigades, of two regiments of infantry, one of cavalry, and one field battery each, would thus be conveyed in 16 trains, each composed of about 40 vehicles; and an army corps containing three such divisions would travel in 48 trains of similar dimensions.

In connection with this subject, it may be interesting to mention what was done on the Brighton railway in 1863, in conveying the Volunteers to the Review near Brighton on Easter Monday. I happen to have the details by me, as I had occasion to obtain them at that

* Soldiers occupy more space in railway carriages than ordinary passengers of the same class, in consequence of their arms and accoutrements.


L.Orta
Guarepo
Gozzano
Arona
Valduggia
Borgosesia
Gattico
Burgomanero
Borgo
Crevacuore
Boca
Sesia
Cressa
Romagnano
Cavallo
Lesiro
Lesio
Dossolo
Sattimaru

time for another purpose. The system of that railway comprised 240 miles, and the Company possessed 145 locomotive engines, 1,858 carriages or passenger vehicles, and 2,588 waggons and trucks, or merchandize vehicles. On the morning of the review, 6,922 volunteers were despatched from the London Bridge station in 9 trains in 2 hours and 41 minutes, and 5,170 volunteers from the Victoria Station in 7 trains in 2 hours and 20 minutes, without difficulty. They travelled to Brighton, 53 miles, in 2 hours and 28 minutes, on an average from the time of starting. The railway company had to provide also on that day for Easter Monday traffic to the Crystal Palace, for all their ordinary traffic, and for 2,000 volunteers along the South Coast from stations on their own line. They carried altogether on that day 132,202 passengers, including volunteers and the holders of season and return tickets. To meet this extraordinary traffic, they borrowed 72 carriages from three neighbouring companies, and 79 carriages brought volunteers to and over their railway from other lines.

I would now refer to some of the leading features of the Italian campaign of 1859, of which so good an account has already been furnished by Major Miller in this theatre. I have marked in black on the excellent map of Lombardo-Venetia which hangs on the wall, the railways that enclose, and in blue some of the rivers that intersect, the country* in which the principal part of that campaign was fought. The railway bridges over the principal rivers, and especially that over the Po at Casale, which was included in the fortifications at that place, were naturally points of importance. The Austrians possessed, as will be seen, lines of communication by railway from Verona, which was their principal base of operations, to the north by the valley of the Adige—to Venice and Udine on the east—to Mantua on the south—and to Milan, Novara, and Vercelli on the west. The Allies, on the other hand, whose base was at Alessandria, had the advantage of railways to Genoa on the south and Turin on the west; and there were railways also to Vercelli and Mortara on the north, and towards Piacenza on the east.

Some of the French troops travelled from Paris to Lyons by railway, [illegible],000 in a day. Some moved from Paris to Genoa in five days. [illegible],000 men are said to have left Paris for Lyons on the night of the 21st of April. A battalion of one regiment went from Lille, through Paris and Lyons, to Marseilles, including the passage through Paris and three hours of detention at Lyons, in 40 hours. The Austrians also sent a fourth corps d'armée by railway from Vienna; and an accident occurred at an early stage of the proceedings, which shows how desirable it is to use separate trains for troops and gunpowder. Nearly 150 Austrian soldiers were killed and wounded in an accident on the Verona railway, during which some of the ammunition waggons exploded.

During their advance into Sardinia and their occupation of the line of the Dora Baltea, the Austrians tore up the rails and destroyed the

* See Plate xxvi.

railway bridges which they met with; but this did not cause any serious impediment to the Allies, because the damage was repaired sufficiently to allow of their being again used as soon as they were required. On the 6th they blew up the railway bridge at Pontecurone, near Voghera; on the 7th that at Valenza; and on the 19th the arches of that over the Sesia, near Vercelli. But the Valenza bridge was afterwards made good by an earthen embankment in place of the two arches that were destroyed, and a Sardinian battery was established, with gabions, fascines, and earthworks, at the west end of it.

The Chasseurs de Vincennes, brought into Turin by successive railway trains, are described as having issued from the station, not fagged and reduced in numbers, as they would have been after a long march; but first at the "pas de charge," and afterwards at a run, with their knapsacks, capotes, tents and poles, batteries de cuisine, &c., &c., on their shoulders; amid shouting, and trumpeting, and clapping of hands; and it is added that "flowers were thrown down from the balconies upon these brisk soldiers as they passed through the streets." How different from the defenders of Sebastôpol, who, from want of railway communication, lost the greater part of their numbers in crossing the steppes on their route to the scene of the conflict!

Between the 19th and 28th May the Austrians occupied a defensive position, not connected by means of railways, extending for about 50 miles along the Sesia and the Po, from Vercelli to Pavia; while the French and the Sardinians, with their principal force at the fortress of Alessandria, were on the line, 30 miles long, from Casale to Valenza and Voghera, on the opposite side of the Po, with the advantage of railway communication, not only from one extremity to the other of that position, but also, in continuation, to Vercelli, Novara, and Milan, on the one side, and to Piacenza on the other. And Milan was the first point which it was the object of the Allies to reach.

The Austrian general, unable to divine that object, and anticipating an attack on his left rather than on his right, removed his head-quarters from the more advantageous position of Mortara to Garlasco, nearer to Pavia, on the 19th May; and on the 20th the reconnaissance was made under his instructions which led to the battle of Montebello.

Count Stadion was directed to attack Casteggio and Montebello about noon, and having taken those places, to use them as a basis for threatening Voghera, and thus to oblige the enemy to display his his strength. He accordingly crossed the Po at Viccarizza, and joining Urban from Stradella, advanced, partly along the railway, and partly by different roads, with 20,000 men towards Voghera. He carried the heights about Casteggio, and pushed on to Genestrello; but Count Gyulai says in his despatch, "The enemy, however, soon displayed a superior force, which was continually increased *by arrivals by the railway*, so that Lieutenant Field-Marshal Urban's and Gaul's brigades, which had come up to his assistance, were compelled, after great loss, but heroic fighting, to fall back on Montebello."

The special correspondent of the *Times*, writing from Pavia on the 21st May, says: "From the heights of Montebello the Austrians

beheld a novelty in the art of war. Train after train arrived by railway from Voghera, each train disgorging its hundreds of armed men, and immediately hastening back for more. In vain Count Stadion endeavoured to crush the force before him before it could be increased enough to overpower him." It is to be observed also that the 74th, 91st, and 98th Regiments were, as stated in General Forey's despatch, dated midnight on the 20th May, employed in defending the railway at Cascina Nuova against the Austrians under Brauen, who advanced along the railway to attack it.

The Austrians retreated, in the words of the Austrian bulletin published in the *Wiener Zeitung*, after the enemy had been obliged to develope his whole force; and they thus claimed to have effected the object they had in view. But what Count Stadion really did, under the orders of Count Gyulai, was this: he advanced towards and partly along a line of railway which was directly connected with the principal base and head-quarters of the allied forces only twenty-five miles from Voghera. With 20,000 men under his command, he was, of course, able at first to push back the advanced posts of the enemy; but in threatening Voghera, and in giving time for a further display of hostile force, he only waited for reinforcements to arrive by that railway. Further delay on his part would have increased the number of his opponents to any amount necessary for defeating him, and it was only by retreating when he did that he avoided a serious disaster.

He discovered, it is true, that there was no great number of the allies in the neighbourhood of Casteggio, but he found out, also, what he does not appear to have anticipated, any more than Count Gyulai, that the railway afforded means for bringing up fresh troops. In reality, a reconnaisance in that particular direction appears hardly to have been required, because the allies could not have advanced towards the strong fortress of Piacenza, or have attempted to cross the Po between Piacenza and Voghera, with any immediate prospect of success.

Between the 25th of May and the 2nd June, and while, therefore, the above battles were being fought, that flank movement was effected by the French which was destined to be the leading feature and the turning point of the campaign.

The Sardinians were concentrated at Vercelli on the 29th May, were fighting at Palestro and Confienza on the 31st May, and moved to the Agogna on the 2nd June.

The third French corps moved from Ponte Curone to Casale, miles, on the 28th May, to Prarolo on the 29th, constructed a bridge there over the Sesia on the 30th, crossed to Palestro in support of the Sardinians on the 31st, and was at Robbio on the 2nd June.

The second corps marched to Casale on the 29th and 30th, reached Vercelli on the 31st, and Novara and Olenzo on the 1st June.

The fourth corps proceeded to Casale on the 29th May, to Borgo Vercelli on the 30th, and to Novara and Olenzo on the 1st June.

The Imperial Guard proceeded to Casale and Vercelli on the 29th and 30th May, crossed the Sesia on the 1st June, and reached Novara and Turbigo on the 2nd June.

The first corps remained at Voghera till the 1st June, to deceive the Austrians, and moved nearly 60 miles from Voghera to Vercelli on that day.

This was undoubtedly a bold and hazardous movement, and one which might have been attended with fatal results, if undertaken in the face of a more active enemy, possessed of better information.

The first corps remained isolated at Voghera, 25 miles from Allessandria, and 50 or 60 miles from the other corps of the allied armies at Vercelli and Robbio. It is true that they were, with the assistance of the railway, only one day's journey from the rest of the army; but the Austrians might, without serious difficulty, have made arrangements for arresting their progress at almost any part of their journey on the 1st June; or they might have cut them off from their communications and annihilated them on either the 30th or the 31st May.

The third corps at Prarolo on the 29th May, and at Robbio on the 2nd June, afforded protection, in conjunction with the Sardinians, from an attack towards Vercelli, as long as the Austrians were inferior in numbers in that direction; but no such protection was provided near Valenza, where the railway is nearest to the river Po, and was most liable to attack. The third and fifteenth Austrian corps were near this important point when the flank movement began on the 28th May, but were afterwards ordered to march northwards. Indeed there was no time during the four days, from the 29th May to the 1st of June, and hardly any point between Vercelli and Voghera, at which the Austrians might not, by better dispositions and rapid movements, have struck such a blow at the French as would have changed the face of the campaign, and perhaps even the issue of the war. They heard the engines and trains at work on the railway between Casale and Vercelli on the night of the 31st May, and they saw French troops on the march from Vercelli to Novara on the following morning, and Zobel requested to be allowed to attack them. But it was only on the 2nd of June, apparently, that Gyulai found out that he had been circumvented, and made up his mind materially to alter the disposition of his troops. He then directed the six corps which lay between the Ticino and the Sesia to retire to the left bank of the Ticino, and the two corps at Pavia and Piacenza to move northward, about the same time that Count Clam, with the first corps, which had been hurried up from Bohemia by railway in an incomplete state, was approaching the Ticino from Verona, also a day too late.

The allies were by this time in an excellent position for moving on Milan. Concentrated in the neighbourhood of Novara, they had only the river Ticino, and the grand canal, guarded by one incomplete corps, before them, while the mass of the Austrian army was further than that of the allied army from the critical point. Their sudden and rapid movement to the north was thus justified so far by success, as rash operations frequently are; but it does not afford an example which should be frequently followed. A flank movement before an active and powerful enemy is always dangerous, because the troops engaged in it are necessarily ill prepared for attack, and are liable to

become engaged at particular points with superior forces. But such a movement in railway trains without adequate support is particularly so. The same precautions cannot be taken as on the march against a sudden attack, a surprise, or an ambuscade. Scattered in different trains along a line of railway, even the infantry, and more especially the cavalry and artillery, cannot readily be disembarked and brought into line-of-battle, and are, for the time, almost without power of resistance.

An obstruction suddenly caused on a railway during the transport of troops, either by the destruction of a bridge, or the displacement of a few rails, as the work of an enemy, or else by the bursting of a locomotive boiler, or a train running off the line, or any other so-called accident, may cause delay for hours or even days, and may be the means, by dividing an army into two or more parts, of exposing it to the risk of being beaten in detail.

These contingencies must never be lost sight of, or left unprovided for, in employing railways for strategic purposes.

The Austrian position on the Po and the Sesia was a good one in the first instance, either for opposing an attempt to cross the Po in the direction of Piacenza, or for striking at the allies during such a movement as actually took place towards Novara. But the only important move which they made from it towards Voghera was a false one; they were otherwise too inactive; and they retained it too long. Either they were too late, or their arrangements were hurried and imperfect at all points, after the battle of Montebello; and this happened principally from want of early and correct information, which, being essential to the success of all military operations, a first-rate commander, acting wisely, always takes measures to obtain. The whole country was no doubt hostile to the Austrians, and the French naturally adopted all the means in their power to keep their projects secret, and deceive their foes. But there are always means of obtaining more or less of information under the most adverse circumstances; and I am the more disposed to insist here upon the necessity for a well organized department for the purpose, because movements may be made so much more rapidly by the aid of steam than by other means. The necessity for having such information at the earliest possible moment, increases in proportion to the rapidity with which an attack may be made, or a position gained. And as railways come more into use for military purposes, so should the "intelligence" department of an army be more carefully organized, and its functions be more efficiently performed.

It should be added, with reference to the strategy of the Emperor Napoleon, that a commander who is engaged in making rapid movements, and who is well informed with regard to the positions of the forces opposed to him, may fairly calculate upon immunity from attack in any particular direction, for a certain period after his plans have to some extent become developed; though it must be admitted that he had no right to reckon upon the Austrians being so much wanting in foresight, activity, or information, as they proved to be both during this flank movement and afterwards, in their dispositions previous to the battle of Magenta.

While, therefore, it would not often be desirable to follow the example of the Emperor of the French, in making so perilous a movement round the position of a powerful enemy advantageously situated, upon the chance of doing so unobserved and unopposed, it would be always inexpedient to follow the example of the Austrians, who left their opponents in free possession of an unobstructed railway almost surrounding their position, and allowed them to transfer the whole of their forces to a most important point, without taking proper measures for informing themselves in regard to their proceedings. They thus lost the most favourable opportunity that the campaign afforded, for striking a blow at their opponents, for gaining the prestige that they so much required, and for materially damaging the allies, without themselves incurring any serious risk in the operation.

The Austrians offered but very slight resistance at Novara when the allies entered that place, and they even abandoned the important masonry bridge at San Martino, over the Ticino, without destroying it. They mined the second pier from the right bank, with the intention of ruining the second and third arches; but the pier was not sufficiently injured to cause the fall of the arches, and the French were able to repair the bridge sufficiently for the passage of troops without difficulty. The Austrians were equally unsuccessful in regard to some of the bridges over the Grand Canal. They blew up the southernmost road bridge at Ponte Vecchio, and one arch of the northernmost bridge at Buffalora; but the latter was made passable for the allies by means of planks which had been carelessly left on the spot; and the more important bridge of Ponte Nuova for the main road, and the iron bridge which carried the railway, fell uninjured into their hands. But for the omission to thoroughly destroy these bridges, the French would still have found serious obstacles in the way of their advance, in the river as well as the canal, and time would have been afforded for the arrival of other Austrian corps.

In spite of these advantages, however, the French narrowly escaped a crushing defeat in the early part of the battle of Magenta. It will be remembered that the Emperor Napoleon had arranged to attack the Austrians in front, and to force a passage over the Grand Canal on that day, while Macmahon, moving southward from Turbigo on the east of the canal, should take them in flank. Having heard Macmahon's guns on the north of Magenta, he advanced with nine battalions of the grenadier division of the guard to attack the bridges over the canal, and gained two of them uninjured—the railway bridge and the Ponte Nuovo. But Macmahon, who had crossed at Turbigo, found unexpected obstacles and opposition to his advance from the north, over 10 or 12 miles, to the scene of the battle. The grenadier division of the guard, which crossed the canal without sufficient support, was well nigh overwhelmed, and Napoleon, under whose immediate directions it acted, was already bringing up artillery to endeavour to cover its retreat when Macmahon's force appeared in the distance. The Austrians this time brought up reinforcements by railway, which afforded them an opportunity for success in the early part of the day; but towards evening the Sardinians arrived in Macmahon's rear, the

French closed in upon the Austrians in increased numbers all round their position, and the Austrians were no longer in a condition to hold their ground. The railway served the Austrians on this occasion, not only as a means of reinforcement, but also as a means of defence. A letter published in the *Times*, written from Ponte di Magenta on June the 5th, to "My dear P.," said: "New and new battalions, "brought up by the railway, the whistle of which was heard, began "to advance to the attack of the position;" and the same correspondent added in a second letter, dated from Magenta on the 7th: "But the "fiercest fight was further behind, on the railway line and the station "house behind it, and the village close by. Pressed back all along "the line, the Austrians concentrated here all their efforts of re-"sistance. In front of the station, beyond the line of rails, is a "large long pit, extending for some distance to the right and left, "and formed by the excavations necessary for the construction of "the line. Besides this, the railway bank, which is somewhat raised, "forms a kind of ready parapet, behind which the defenders enjoyed "some protection. The station, as well as the neighbouring build-"ings, and a square, solid campanile, were filled with riflemen, "while the troops of the line massed themselves in front of them. "As the troops came up they were brought out here, and took the "place of their exhausted comrades. To carry this strong position, "the Fusiliers and Chasseurs of the Guard were ordered forward. "They broke through, driving the enemy before them, until their "course was arrested by the line of strong wooden railings. A few "common shot would have easily brought them down, but there was no "place whence to bring them to bear, so nothing remained but to "tear them down by main force and the axes of the sappers."

The Austrians abandoned Milan and retreated so hurriedly after the battle that they did not even destroy the railway or carry off the rolling stock. The Milanese sent a train to Magenta the next morning for the wounded, and the remainder of the wounded and the prisoners followed as speedily as they could be transported in other trains to that city.

The French owed, then, much of their advantage in this part of the campaign to the way in which they utilized the railways at their disposal.

In the first position they took up, from Casale to Voghera, they had, as we have seen, the great advantage of railway communication between the extremities of that position and with the fortress of Alessandria, which served as their base, near the middle of it. They were enabled, first to convey reinforcements by railway to Forey, when he was engaged at Montebello, on the east of that position; and afterwards to move rapidly northward, and by a circuitous route, towards Milan by the aid of the railway, with a secrecy, facility, and rapidity, that would otherwise have been impossible. And railway bridges gave them important assistance in crossing the various rivers and streams that they encountered.

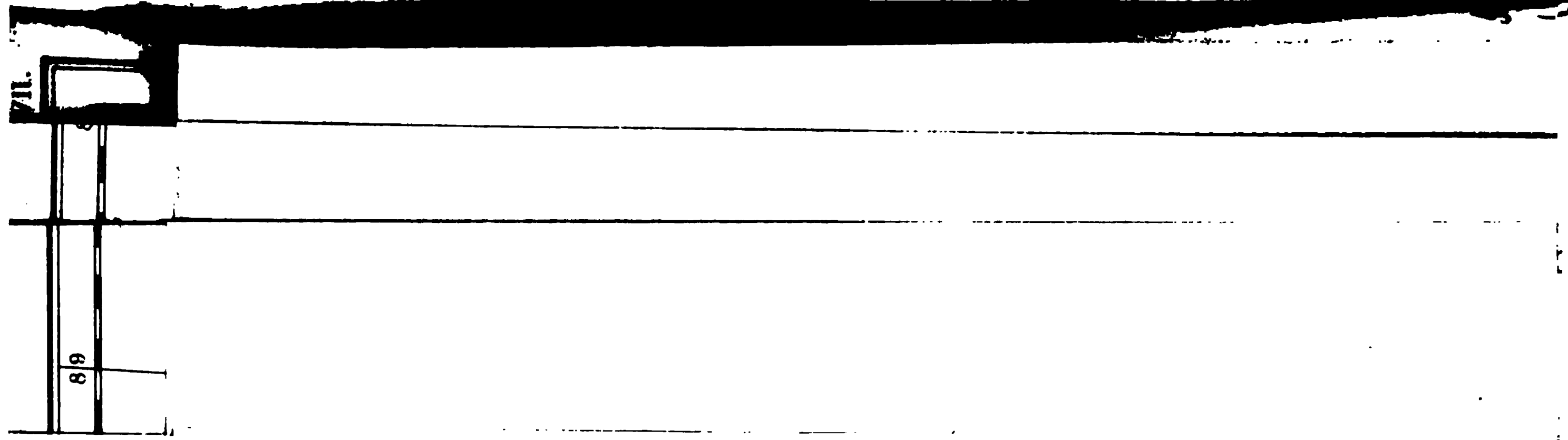
On the other hand, they would have found the route open from Novara to Milan, and would have been almost unopposed in crossing

the Ticino and the Naviglio Grande, if Count Clam Gallas had not arrived with his corps by railway in the opposite direction; and although the Austrians were surprised (in a military sense) by the rapid movements of the French, and were unprepared to meet them with the mass of their forces on the advance from Novara, the railway yet proved useful to them during the battle of Magenta. It enabled them to bring up reinforcements which they could not otherwise have received; and a railway embankment (which was subjected by General Auger to a flank and cross fire from 40 guns), served them for a breastwork, a railway *side*-cutting for rifle-pits, a railway fence for palisading, and a railway station for a block-house, at the most critical part of the fight. Their omission to destroy the railway to Milan after the battle, which afforded a good means of transport to the wounded, did them no great harm.

And here I would observe that, although failure to secure the destruction of railway bridges and works which may be of use to an enemy, as in the case of the bridge of St. Martino, is a serious fault, and may lead even to the failure of a campaign, yet a commander will always act wisely in abstaining from injury to a railway (as well as to any other work of public utility) which can afford no military advantage to an enemy. The importance of destroying such works depends, not upon the amount of damage that can be effected, but upon the means that are at hand for repairing it, and the time that can be afforded for doing so before they are required for use.

I need not follow the Austrians in their retreat behind the Mincio, nor the French in their cautious pursuit. Neither during these operations nor in the subsequent advance of the Austrians towards the Chiese, which led to the magnificent and hard-fought battle of Solferino, in which two Emperors and a King commanded their respective armies, were railways directly made use of, and therefore they do not present any incidents of interest connected with our present subject.

I now turn to another, and a very different theatre of war. The Italian campaign was concluded in two months, and the principal operations extended over a space of about 100 miles long, from Vercelli to Solferino, and 50 miles wide from Turbigo to Tortona. The civil war in America, which only now begins to show real symptoms of termination (from failure of confidence, and therefore of credit in the north), has lasted for three years, and has extended over an area some 900 miles long by 800 miles broad. The Italian theatre was traversed by numerous roads and substantial bridges, the destruction of which required more skill and powder than the Austrians had always at their command. But we have now to consider a country containing roads or tracks comparatively few in number, and often in very bad order —railways of great length, but cheaply constructed—numerous rivers spanned in many cases by wooden bridges and viaducts, which require no more than a lighted torch to ensure their destruction. The railways and rivers in America have been, in consequence of the distances to be traversed, and the indifferent character of the roads, of paramount importance in a military point of view; and the telegraph wire has partly superseded, for similar reasons, other means of transmitting orders, or


7L.
6/8

of reporting from the different scenes of operations those results which have too often turned out to be either false or imaginary. The line of railway is there in many cases the only practicable means of communication and transport, for moving an army as well as for supplying it with provisions, stores, ammunition, and reinforcements, and it becomes itself a primary object of attack. Expeditions are organised, or raids undertaken, for tearing up rails, for burning wooden sleepers and timber beams, for capturing or destroying engines, carriages, and trucks, and for rendering a railway temporarily useless. Battles are fought for the possession of a junction between two or more railways, and these junctions become strategical positions of the first importance.

The main objects of the Northerners are of course (1) to take possession of the Southern capital so near to them at Richmond; (2) to secure the navigation of the Mississippi and other rivers; (3) efficiently to blockade the southern ports, and (4) to seize important posts on the coast and inland, with a view to the subjugation of the seceded states. The objects of the Southerners, on the other hand, are strictly defensive, and their operations are therefore mainly confined to active resistance at the several points of attack, with a view to ultimate freedom from Northern domination.

Taking a general survey of the scene of operations, the points to which I would now particularly direct attention upon the map* are, (1) the two capitals—Washington and Richmond, shown by dark marks, within 100 miles of one another; (2) the Ohio and Mississippi rivers, forming one continuous river line 1,200 or 1,500 miles long, from Pennsylvania to New Orleans, with the Cumberland, the Tennessee, and its other tributaries shown in blue; (3) the Potomac, the Rappahannock, the York river, and the James river, in the vicinity of Washington and Richmond, also in blue; (4) the railways (shown in brown) of greatest importance for strategic purposes, comprising—the route along the Potomac from Washington to Cumberland and Cincinnati—the main route from Washington and Richmond on the east to Memphis on the Mississippi—the north and south routes from Memphis by Jackson, Mississippi, to New Orleans, and from Columbus by Corinth to Mobile—the line from Louisville to Memphis crossed by the through route, past Nashville and Chattanooga, to Atlanta and the whole of the south-eastern states—the three communications with Richmond, (*a*) from Washington by Gordonsville on the north and west; (*b*) from Aquia Creek and Fredricksburgh on the north; (*c*) by the York river railroad on the east.

In consequence of the want of rails for renewals, and of sufficient engines and other rolling stock, the Southerners appear, in spite of their possessing this system of railways, to have laboured under very serious difficulties of transport, and they have at times been hardly able to furnish supplies for their armies. Without these railways, they could not possibly have carried on the war on the same scale, or with the same success. The railways have indeed been their principal allies;

* Vide Plate xxvii.

they form the key by which the object of almost all their inland operations may be understood; and their course has served to determine the site of almost all their positions; while the lines of the great rivers, on the other hand, have necessarily been followed by the Northerners in their aggressive operations. No great northern army has been able to maintain itself for any length of time, even with the aid of railways, more than a day's march from the sea or from a great river, and no great Confederate army has been able to remain or can remain far away from a line of railway. Over and over again they have been unable, without railway communication close at hand, either to continue a battle or to follow up a victory, for want of ammunition, which their other means of transport does not enable them to carry in sufficient quantity.

In the short time here allotted to me, I can only dwell briefly upon portions of some of the operations that have been carried on over this vast area, and over this lengthened period. I have selected a few examples that may best show the mode in which railways have been employed, and thus illustrate my subject. I shall have occasion to give some extracts from American newspapers, but I cannot feel that they are by any means reliable sources of information. Many of the reports on military and naval subjects are mere fiction, and are no more to be believed than the story of a dog and his tail, which appeared in the advertisement of a New York paper not long since, about the same time that the celebrated Report by the Secretary of the Confederate Navy, which so completely deceived us on this side of the water, was published in New York.

The different campaigns in Virginia, which first claim our attention, commenced in struggles for the possession of railway junctions, and the last important movement was principally for the purpose of destroying the Orange and Alexandria railway.

M'Clellan's successful action at Grafton, the junction of the railway between Cincinnati, Harper's Ferry, and Washington, with the railway to Wheeling, was almost the first operation of the war; and his seizure of that important place was the means of obtaining further success at Beverley and Huttonsville, and of driving the Southerners out of western Virginia.

The still more important point of Harper's Ferry, where the Shenandoah river joins the Potomac, where the railway from Winchester (the capital of the Shenandoah valley) joins the main line to Cincinnati and Washington, and where the eastern ridge of the Blue Mountains falls towards the river, was held by the Confederates until the middle of June, 1861, when the Northerners advanced in overwhelming numbers to occupy it. It afterwards became famous in consequence of the capture of Federal troops and stores effected there by Stonewall Jackson, under Lee, on his first invasion of Maryland.

The next place to which I would refer, is the Manassas junction, at which the railway from the Shenandoah valley and Front Royal joins the main line from Washington and Richmond on the east to Memphis on the Mississipi. Of the two pitched battles (of Bull Run) which have been fought near this place, the first took place on the 21st July,

1861. After retiring from Centreville on the 18th July, Beauregard posted his (Southern) forces on the north of the junction; and M'Dowell "concluded" to cross two fords over the Bull Run stream with the mass of the Northerners, in order to turn the enemy's left, and to destroy the railway on the west of the junction. Beauregard reinforced his left wing; Southern reinforcements, arriving by railway, left the train before it arrived at the station, and attacked the right and rear of the Northerners; and the Northerners, unable to stand such an attack, or to rally after it, fled in disorder.

The Northerners advanced to the attack on this occasion to the tune of Yankee Doodle, hardly calculated, perhaps, to inspire them with much martial ardour; and the Southeners, who are endowed with a lively wit, and have composed several songs to that tune in the course of the war, described the fight and its results in the *Richmond Whig*, in a piece of poetry which is too long to give here and is not fitted to so select an audience, but in which occurs the lines—

> "Yankee-doodle wheeled about,
> "And scampered off at full run,
> "And such a race was never seen,
> "As that he made at Bull Run."

The second battle of Bull Run, on the 29th and 30th August, 1862, which also ended in favour of the Confederates, was fought between Jackson with 30,000 men on the first day, and Jackson and Longstreet, under Lee, with 45,000 men on the second day, against Pope at the head of 60,000 men. The positions of the contending armies were almost reversed on this occasion. Pope had advanced, in compliance with orders from Washington, towards the Gordonsville junction, in order, by threatening that junction (between the railways from Washington and Richmond, to Staunton and the Mississippi), to draw off attention from M'Clellan, and to allow of his army being extricated from its disastrous position on the peninsula east of Richmond.

In their several advances towards Richmond, the Federals have hitherto adopted the lines laid down for them by the railways. On the map, the route through Fredericksburg appears at first sight the most inviting, because the railroad through that place is nearly in a straight line in continuation of the Potomac, and is connected with a most convenient water-base at Aquia Creek, immediately to the south of Washington; but the difficulties by that route have hitherto proved to be insuperable. And, indeed, a railroad 65 miles long, as a sole means of communication with the base of operations, is too precarious to be relied upon in a hostile country for the continued supply of a very large army. Supposing that a large Federal army could, after safely crossing the Rappahannock, and after gaining instead of losing battles near Chancellorsville or Fredericksburg, be advanced by this line to some point near Richmond, its commander must then either leave a considerable part of his force to guard the line of railway, or run the risk of having the railway destroyed in his rear, and of being thus cut off from the means of either supply or retreat. Under these

circumstances, and because the route by Gordonsville offered still further difficulties of the same description, M'Clellan determined early in 1862, to advance along the peninsula from the east, so as to obtain the advantage of water communication to within a shorter distance of the southern capital.

When he reached the White House he had the advantage of the York River railroad, only 35 miles long, to communicate with the enormous depôt which he had formed on the Pamunkey River. He repaired the railway without difficulty, and employed it for the supply of his army, but he required considerable detachments to guard it, and could not, even then, do so effectually. The Confederate cavalry, under Stuart, made a circuit round his rear, set fire to two of his transports, fed upon his provisions; and, disappointed of support from M'Dowell, who had been recalled to protect Washington in consequence of Jackson's exploits in the Shennandoah Valley, he was glad enough to escape, after the seven days' fighting on the Chickahominy, to Turkey Bend, and to seek refuge under the fire of his gunboats, on the banks of the James River.

But it was the sudden and unexpected return of Jackson by railway from Staunton, at the head of the Shenandoah, that contributed more than anything to the dismay of the Federals and the defeat of M'Clellan on this occasion. And the combination of marching and railroad travelling effected by Jackson, in first defeating the different armies opposed to him, at considerable distances from his railway-base at Staunton,—and then, after alarming the Federal authorities for the safety of Washington itself, returning by a rapid railway journey, to attack the right flank of the main army of the Federals before Richmond, when he was thought by them to be still in the north, is, perhaps, the most interesting and instructing episode in the whole war. It afforded the lessons that the Federals most required to learn, and that we may all study with benefit, in showing that whatever advantages may be possessed of railroad communication, the best opportunities must still remain with those forces which are prepared to march rapidly, as well as to travel by train when the occasion requires—that an army must not, because railway facilities are at hand, be unnecessarily encumbered with extra stores and baggage—that, in fact, locomotives must not supersede legs, and must not be made an excuse for useless encumbrances.

These operations afford, also, a valuable example of the advantage of even partial railway assistance in defensive warfare, and on interior lines, and of the minor use that can be made of them in aggressive warfare, in an enemy's country.

The last considerable operation that took place in these quarters, was when Lee, crossing the Rapidan in October last, pushed the invading army of Meade back upon the defences of Washington, by suddenly threatening his communications along the Orange railway. It was at first supposed by the Federals that the Confederates intended on that occasion to make another raid into Pennsylvania; but the event proved that their principal objects were, partly to take any opportunity that offered of advantageously engaging the Federal army,

and to seize what prisoners and booty they could from that army; but especially by destroying the railroad itself, to prevent the possibility of a further advance in that direction for some time to come, and perhaps for the remainder of the year. Those objects were fully attained. Meade saved, indeed, the bulk of his army from any great disaster, by a timely and active retreat. But he is said to have lost 7,000 prisoners and a vast quantity of material in doing so. A correspondent of the *New York Times* said, "The desperate dashes which "they made at our trains, show, too, how greedy they are for booty;" and, he added, with regard to the Orange Railroad, 24 miles of which were destroyed on this occasion;—"This work has been very thoroughly "done, Lee's whole army having been engaged on it for two days. "From Bristol to the Rappahannock the destruction is complete— "bridges burnt, culverts blown up, ties taken up and burnt, rails "twisted and rendered useless, cuts filled up, &c. The engineers say "that it will be at least a month before it can be again put in running "order. It is with no small mortification, therefore, that we have to "confess the rebels have achieved an end fully commensurate with "the labour and risk of the campaign."

It will be an interesting study to compute at the end of the war, how many times different portions of railway have been destroyed and renewed, what proportions of construction and destruction have been effected by the Federals and Confederates respectively, and how many miles of new railway might have been constructed with the labour, money, and materials, that have been so freely lavished in these operations. Regular conspiracies were deliberately formed in some states for the destruction of railroad works and bridges; and, it has frequently occurred, as the lines of operation varied, that each side was glad to make use of portions of railway which they destroyed at other times, when they were likely to be of advantage to the enemy. I may here refer to some of the instances in which railway works have been destroyed, as showing the precarious character of railway communication, especially when timber bridges and viaducts are employed.

During the riots at Baltimore at the commencement of the war, the mob destroyed the station and burnt the bridge over the Susquehanna, as soon as the troops had started in the trains for Washington.

When the Confederates evacuated Harper's Ferry in June 1861, they destroyed, says Colonel Estran, "that wonderfully constructed "railway bridge which here spans the broad stream of the Potomac." At a given signal this structure was blown into the air with a terrific explosion. All the buildings connected with it, the station, engines, locomotives, warehouses, as well as a flourishing town, with all its trade and prosperity, were condemned to destruction.

Colonel Estran also relates how that when the Confederates evacuated Newbern, about February 1862, they retreated across the "fine railway bridge which here spans the river Reuss;" and he adds: "The Federal troops now delivered so deadly a fire that our troops "were driven from their positions, and we had to cross the bridge, to "which we set fire immediately after, in order to prevent its falling "into the hands of the enemy. In a few moments dense columns of

" smoke denoted that this work of destruction was in progress. Whilst " this noble bridge, the pride of the people of North Carolina, was " thus becoming a prey to the flames, the enemy actually stopped " firing, to witness the grand and awful spectacle. The flames rapidly " increased, the timbers crackled, and the whole structure finally fell " with a tremendous crash into the river below, and then for a brief " interval all was still again." It appears that "General Branch, who " commanded the Confederates, had previously secured a railway " carriage to himself, and started off inland," and that he afterwards (as it is quaintly stated) "found it no easy task to re-establish his " reputation for bravery."

When John Morgan, the Guerilla leader, made a raid on the small town of Gallatin, 20 miles north of Nashville, then occupied by the enemy, he proceeded to the railway station, and on the arrival of the train took prisoners the engine driver and five officers who were in it. " He then had all the carriages set fire to, and covering the engine " with turpentine, tow, and other inflammable matter, he sent it back " on fire at full speed towards Nashville."

It is stated in the *New York World* of June 15th, 1861, that "Some " disunion troops from Leesburg, Virginia, burnt four bridges on the " Alexandria, London, and Hampshire Railroad, at Tuscarora, Lycoline, " Goose Creek, and Beaver Dams, being the balance of the bridges " from Leesburg to Broad Run." On November 9th, two road bridges on the Georgia State road, two on the Chicamauga Creek and Hamilton County, three on the Eastern Tennessee and Georgia road, were all burned by the Union men of East Tennessee. On November 13, one bridge 200 feet span, four bridges north of Knoxville, and one very heavy bridge at Charleston, 75 miles south-west of Knoxville, were also burned.

The *St. Louis Democrat* of October 17th gives also a circumstantial account of the burning of the Big River Bridge—the principal bridge on the Iron Mountain Railroad. It appears that the 40 or 50 men who had been stationed in the neighbourhood to guard it were overpowered. A railroad train, which arrived about this time, was sent back for reinforcements. But they arrived too late—to find the timbers burning, the rails torn up on each side of the bridge, and the telegraph wires clipped.

But the horrible system which was adopted, of half burning the bridges with a view to the trains "falling through," affords stronger instances of the disadvantage of travelling by railway through a hostile country.

On the 3rd September, 1862, the Secessionists of Missouri burned several of the bridges on the Hannibal and St. Joseph Railroad; and on a train with nearly 100 passengers coming up to the Little Platt river, the bridge gave way, and precipitated the whole train down an embankment with terrible slaughter. And the *Louisville Journal* of September 13th, 1862, says: "Another fiendish attempt to destroy the " lives of national soldiers was made a day or two since on the North " Missouri Railroad. The timbers of a bridge near Sturgeon were " partially burned, in expectation that a train loaded with troops would

" be precipitated into the creek below, but the design of the villains " being known, the train stopped at Mexico, *and the troops encamped* " *at that place*, where they *remained until the bridge was repaired.*"

The campaigns of Tennessee and the West have not been reported to us so much in detail as those in Virginia. Northern misrepresentation and Southern reserve have united to envelope many parts of them in mystery. But they are not less interesting, and certainly they redound far more to the credit of the Northerners. As soon as time had been afforded for the necessary preparations, the Federals possessed great advantages in being able to place gun-boats upon the Mississippi, and Tennessee, and other rivers, and by their communications by railway from all parts of the Northern States; and Cairo was soon occupied by the Federals. But Lexington on the Missouri was taken, with its stores and money, by the Confederate General Price. A series of advances, retreats, and conflicts was followed by a struggle for the possession of the unfinished railway from St. Louis to Memphis. At length the Federals prepared a joint expedition of troops and gunboats, with which to take advantage of the rivers of the country. The Southerners held Columbus on the Mississippi as late as January, 1862, and made a stand for some time at Bowling-green, where the railroad from Louisville to Memphis joins the railroad southward to Nashville. But on the 6th February, 1862, Fort Henry, a small work on the Tennessee, was captured. Bowling-green was evacuated on the 15th February; and Fort Donnelson, an important work on the Cumberland river, and on the Memphis and Louisville railroad, surrendered with 12,000 prisoners and great quantities of artillery and stores to General Grant and Commodore Foote the next day. This was a terrible and unexpected blow to the Southerners. Nashville, an important railroad junction, their base of operations in this direction, the capital of Tennessee, and containing vast quantities of specie, ammunition, and stores, became untenable, no preparations having been made for so unforeseen an event. The Confederates destroyed as far as possible their gunboats, provisions, and such valuables as they could not remove, and then occupied Jackson, Tennessee, and afterwards Corinth; and they retained that junction between the Memphis and Charleston railroad and the south line to Mobile for a considerable period. Beauregard's head-quarters were at Jackson in March, 1862. On the 3rd April General Sidney Johnson issued an address at Corinth to the (Southern) army of the Mississippi, of which Beauregard was second in command; and on the 6th and 7th April they turned upon the Federals at Pittsburg, and fought that desperate battle which has been styled by the former the battle of Pittsburg Landing, and by the latter the Victory of Shiloh.

During these operations the Confederates clung to the railways by Jackson Tenn, on the west, and by Murfreesborough, south of Nashville, the scene of other important engagements, on the east; and they made important use of these railways, as appears from Beauregard's report, to concentrate their forces for the fight at Pittsburg. The Federals on the other hand employed the Tennessee river in their advance, and it was their approach by that river to the Memphis and

Charleston railroad that induced Beauregard to attack them at Pittsburgh. But the Confederates were at length driven back all along their line to the important through line of railroad already referred to as joining the prolongation of the Orange and Alexandria railroad, and thus connecting Washington and Richmond with the Mississippi. This through line has been employed, it will be remembered, to great advantage by the Confederates in transferring troops from Virginia to Tennessee, and *vice versâ*, over a distance of about 500 miles, and notably on the occasion of the battle of Chicamauga, which was won by the sudden appearance of Longstreet and his troops from Virginia. This line is now held by the Federals at Chattanooga and Knoxville, at both of which places it joins the Tennessee river. The position of Chattanooga I would advert to as being a particularly important one, as will be seen by a glance at the map. Besides being situated on the Tennessee river, it is the point on which all the railway communications of this region converges, from Washington and Richmond on the east, from the whole south-east by Atlanta, from Memphis on the west, and from the whole north and west by Nashville and Louisville. But this position, however valuable to hold, is by no means an easy one for the Federals to advance from, as long as the Confederates are able to maintain a sufficient force in their front, because they would leave the river behind them, and be obliged to trust to railway communication, which is already liable to interruption between Chattanooga and Nashville, and which would be still more so as they approached Rome and Atlanta.

To show the feelings of the Northerners when they reached the Memphis and Charleston railroad, and as an example of the advance of a body of Northerners in an exceptional way, I would quote the following in regard to the march upon, and capture of, Huntsville, on the 11th April, 1862. A correspondent of the *Cincinnati Gazette* says, April 11, 1862:—"We have achieved a victory which, although blood-
"less, must be attended by such important results as can hardly
"be over-estimated. The main line, and for all practical military pur-
"poses the *only* line of communication between the eastern and
"western armies of the enemy, is in our hands. To General Mitchell
"and his brave troops belongs the distinguished honour of being the
"first to penetrate to the great Charleston and Memphis railroad,
"and the first to break the rebels boasted line of defence, extending
"from Chattanooga to Corinth.

"We all perfectly understand, too, that the rebels had accumulated
"upon this road nearly all the rolling stock of all the railroads from
"Bowling-green southward, besides what legitimately belonged to
"the road itself; and that they could therefore concentrate at any
"threatened point whatever forces they had at command.

"An advance force of a hundred and fifty cavalry, together with a
"section of the battery in charge of Captain Simonson himself, assisted
"by Lieut. M. Allen, commanding the section, the whole directed by
"Colonel Kennet, first caught sight of Huntsville, and the lovely
"cedars surrounding it. They were advancing upon the double quick,
"when two locomotives, with trains attached, suddenly made their
"appearance upon the railroad. They were moving in the direction

" of Stevenson. A shot from one of Simonson's guns brought the " first one to. The captain then turned to pay his respects to the " second. A shot or two induced it also to haul up. In the meantime " the engineer of the first train was quietly getting on a full head of " steam, and when nobody was suspecting such a thing, he suddenly " started off. The cavalry went in pursuit, and actually chased the " locomotive for a distance of ten miles.

" A few horsemen tried their carbines upon the second train, and an " unfortunate coloured person received one of the bullets in his neck. " It was said too by the secesh that a rebel from Corinth, going home " slightly wounded, was instantly killed.

" The infantry had come up while this was going on, and Colonel " Mihalotzi, of the twenty-fourth Illinois, sent a detachment to tear " up a portion of the track in the direction of Decatur. The escape of " any more trains was thus effectually prevented."

And Brigadier-General O. M. Mitchell says, in a General Order (No. 93), dated " Head-Quarters, Third Division,

" Camp Taylor, Huntsville, April 16, 1862.

" Soldiers,—Your march upon Bowling-green won the thanks and " confidence of our Commanding-General. With engines and cars " captured from the enemy, our advance guard precipitated itself upon " Nashville. It was now made your duty to seize and destroy the " Memphis and Charleston Railway, the great military road of the " enemy. With a supply train only sufficient to feed you at a distance " of two days' march from your depôt, you undertook the herculean " task of rebuilding twelve hundred feet of heavy bridging, which by " your untiring energy was accomplished in ten days.

" Thus, by a railway of your own construction, your depôt of sup- " plies was removed from Nashville to Shelbyville, nearly sixty miles, " in the direction of the object of your attack. The blow now became " practicable. Marching with a celerity such as to outstrip any mes- " senger who might have attempted to announce your coming, you " fell upon Huntsville, taking your enemy completely by surprise, and " capturing not only his great military road, but all his machine-shops, " engines, and rolling stock.

" Thus providing yourselves with ample transportation, you have " struck blow after blow with a rapidity unparalleled. Stevenson fell, " sixty miles to the east of Huntsville. Decatur and Tuscumbia have " been in like manner seized, and are now occupied. In three days you " have extended your front of operations more than one hundred and " twenty miles, and your warning gun at Tuscumbia may now be " heard by your comrades on the battle-field made glorious by their " victory before Corinth.

" A communication of these facts to head-quarters has not only won " the thanks of our Commanding-General, but those of the Depart- " ment of War, which I announce to you with proud satisfaction.

" Accept the thanks of your Commander, and let your future deeds " demonstrate that you can surpass yourselves. By order of

" O. M. MITCHEL,

" W. P. Prentice, A.A.G." " Brigadier-General, Commanding."

This force moved from Bowling-green to Nashville and Shelbyville, about 140 miles, by railway, and afterwards marched about forty miles to Huntsville. They did not acquire much glory in marching upon Bowling-green, or in precipitating themselves upon Nashville, because those places had previously been evacuated by the enemy. But they performed so great a feat in construction, by building 1,200 feet of heavy bridging in ten days, that I must leave the statement to the credibility of the Brigadier-General. They captured 17 locomotives and 150 cars at Huntsville.

I need not further refer to the fighting on the Mississippi, except in one particular. I would point out that the entrenched position of Vicksburg, which formed the principal defence of the Confederates upon that river, and which was so long and so gallantly maintained by them, existed as a military post in consequence of the communication by railway which it possessed with the country east and south of it. Its garrison resisted all bombardments and assaults by sea and land as long as that means of communication remained open, and only fell for want of supplies after it had been closed. Without that key to solve the problem, it would not be possible to understand the operations which led to its capture. The Federal General Grant obtained success last year, not by a direct attack upon it, but by marching from Grand Gulf, 20 miles south of it, to Jackson, 50 miles east of it. The possession of the latter place—at which the north and south railroad from Columbus to New Orleans joins the railroad running eastward from Vicksburg to Selma—enabled him to prevent all approach to it, to cut off all chance of supply, and thus to render it untenable.

The general lessons which may, as it appears to me, be deduced from what is at present known on the subject, are that: (1.) Railways may, when available, be often used with great advantage on a theatre of war, as an auxilliary means of moving troops, and as a principal means of supplying them. (2.) Railways are more quickly and easily destroyed and more readily repaired (in a temporary manner) when the necessary materials are at hand than common roads. (3.) A single line of railway, in good order, and furnished with a proper proportion of sidings, crossing-places, and rolling stock, is sufficient for the ordinary supply of any army in the field. (4.) Railways constructed with a view to strategical purposes, and intended for the conveyance of troops, should be laid with a double line of rails. (5.) A commander should in no case rely altogether upon a railway for communication with his base of operations in a hostile country, and should not rely too much upon a long line of railway, subject to attack from an enemy, in any country. (6.) Railways may be employed to much greater advantage in defensive than in offensive warfare. (7.) Railway junctions will often become strategical positions of the greatest importance. It is further plain, that as railways increase in number, and come into common use in military operations, so it will become more desirable that every soldier in an army should be able to assist in destroying or repairing them. I have had occasion to point out in

previous lectures* that the use of the spade in warfare will necessarily increase with the common employment of, and with a growing proficiency in the use of, rifled weapons; and I would now add that the use of railways in war will render it still more desirable that every soldier should be trained to be more or less of an engineer.

The best mode of imparting such training to British soldiers will be—not merely by putting them through an appropriate course of instruction—but by also employing them, or allowing them to work under proper restrictions, at trades and on works of public utility.

The day has gone by when a soldier's efficiency was supposed to depend more on the stiffness of his stock than upon his power to hit an enemy. A well trained, or an educated man, is not now considered likely to make a worse soldier than an ignorant boor. A commencement has been made under our enlightened Commander-in-chief with great success at Portland and Dover, in employing British soldiers, as those of other nations are employed, upon public works, and I hope that we may see that system very much extended. The soldier will become a more useful member of society, will be enabled to increase his means of subsistence, and will be materially raised in the social scale. Drill, discipline, and shooting, which are the first considerations in a military point of view, will not be less well learnt, or less remembered; temptations to strong drink and vicious habits, which are the result of a want of sufficient occupation, will in a great measure be removed; practice in actual work at home will make him more active, more handy, and more ready to perform any duties that may be required of him abroad or in the field; and he will be better able to provide for himself, and less dependent upon others, when his term of military service is completed.

* *Vide* lectures on "The Rifle and the Spade," 1st April, 1859; and "the Effect of the Modern Rifle upon Siege Operations," 16th April, 1858, at the Royal United Service Institution.

NAVAL AND MILITARY WORKS.

Royal Warrants, Circulars, General Orders, issued by War Office and Horse Guards, August 1856 to July 1864, by Brevet-Major J. M. Bannatyne. 16*s.*

Suggestions for Improving the Law and Practice of Courts Martial, by Captain L'A. Hale, R.E. 1*s.* 6*d.*

Records of the 44th Regiment.

Ledieu. Traité élémentaire des appareils à vapeur de navigation, rédigé pour la partie pratique par les premiers maîtres mecaniciens de la marine impériale. Tomes 1 et 2, avec atlas. 2*l.*

Chesnel. Dictionnaire des armées de terre et de mer, bibliothèque du soldat et du marin. 2 vols. royal 8vo. 1*l.* 5*s.*

Beaugé. Cours d'administration militaire à l'usage des officiers des corps de l'infanterie. 16mo. 5*s.*

Bourson. Résultats des expériences exécutées à West-Point avec des bouches à feu de gros calibres pendant les années 1852 à 1855. 8vo. with plates. 5*s.*

Brialmont. Etude sur la defense des états et sur la fortification. 3 vols. 8vo., and atlas in folio. 3*l.* 15*s.*

Bué. Ordonnance sur l'exercice et les évolutions de la cavalérie du 5 Décembre, 1829, appropriée à chaque arme. 8 vols. 18mo. 6*s.*

Cavalli. Mémoire sur la théorie de la resistance statique et dynamique des solides, surtout aux impulsions comme celles du tir des canons. 4to., with plates. 10*s.*

Conférences sur les manœuvres d'infanterie Prussienne, Autrichienne, Swedoise, Belge, Espagnole, Piemontaise, Anglaise, Russe. Par. E. T. 8vo. 3*s.*

Todleben (General E. de). Défense de Sebastopol. Volume I in two parts, of text, 4to.; and part I of atlas, in folio.

Paris. Supplément à l'art naval à l'exposition universelle de 1862, ou dernière inventions maritimes. 8vo., with 11 plates. 4*s.* 6*d.*

De la Barre Duparcq. Histoire de l'art de la guerre avant et depuis l'usage de la poudre. 2 vols. 8vo. 15*s.*

——————————— L'art militaire pendant les guerres de religion. 8vo. 2*s.*

Etude sur l'administration militaire en campagne. 4to. 1*l.*

Beaulieu. Mémoire sur deux nouveaux systèmes de Pont-Levis. 8vo., with plates. 2*s.* 6*d.*

Ratheau. Examen critique des Etudes de M. Brialmont sur la defense des états et sur la fortification. 8vo. 1*s.* 6*d.*

Lecomte. Campagnes de Virginie et de Maryland en 1862, Documents officiels, &c., avec cartes. 8vo. 5*s.*

Mémorial de l'officier du génie, ou Recueil de mémoires, expériences, observations et procédés généraux propres à perfectionner la fortification et la construction militaires, rédigé par les soins du comité des fortifications. No. 17. 8vo. 1*l.* 5*s.*

Coquilhat. Percussions initiales produites sur les affûts dans le tir des bouches à feu. 8vo. 7*s.* 6*d.*

Décret sur le service à bords des bâtiments de la flotte, annoté de toutes les dispositions qui ont modifié ce décret jusqu'à ce jour (Août 1863). 2*s.* 6*d.*

Martin. Constitution et puissance militaires comparées de la France et de l'Angleterre. 8vo. 8*s.*

Favé. Etudes sur le passé et l'avenir de l'artillérie. Ouvrage continué à l'aide de notes de l'Empereur. Tome IV. contenant l'histoire des progrès de l'artillérie. 4to., with plates. 1*l.* 10*s.*

Pervenger. Expériences exécutées avec des bouches à feu rayées sur la citadelle de Molina d'Aragon, d'après le mémorial d'artillérie Espagnol. 8vo., with plates. 8*s.*

Magnus. Sur la déviation des projectiles, trad. par Rieffel. 8vo., with plates. 6*s.*

Correspondance politique et militaire de Napoléon I, publiée par ordre de l'Empereur Napoléon III. Tome 15. 8vo. 6*s.*

Augoyat. Aperçu sur les fortifications, les ingénieurs et sur le corps du génie en France. Tome III. (1790 à 1804). 8vo., with plates. 7*s.* 6*d.*

Piron. Mémoire sûr un pont roulant simplifié pour les communications militaires. 8vo., plates. 1*s.* 6*d.*

——— Projet de pont glissant pour les communications militaires. 8vo., plates. 1*s.* 6*d.*

Abrichtungs Reglement für die k. k. Fusstruppen. 8vo., with plates. 4*s.*

Abrichtungs Reglement für die k. k. Kavallerie. 8vo., with plates. 6*s.*

Dienst Reglement für die k. k. Artillerie. 2 vols. 16mo., with plates. 6*s.*

Plönnies. Neue Studien über die gezogene Feuerwaffe der Infanterie. 2 vols., 8vo., with illustrations. 12*s.* 6*d.*

Ruestow. Die Lehre vom kleinen Kriege. 8vo. 6*s.* 6*s.*

Möring. Felddienst des k. k. Geniestabes. 8vo. 18*s.*

LONDON: PRINTED BY HARRISON AND SONS, ST. MARTIN'S LANE.

The Journal

OF THE

Royal United Service Institution.

VOL. VIII. 1864. No. XXXIII.

LECTURE.

Friday, May 27th, 1864.

HIS GRACE THE DUKE OF SOMERSET, K.G., First Lord of the Admiralty, in the Chair.

SOME NEW POINTS IN THE HISTORY AND APPLICATION OF GUN-COTTON.

By F. A. ABEL, Esq., F.R.S., Chemist to the War Department, Royal Arsenal, Woolwich.

MR. ABEL: About thirty years ago two substances were discovered in France, possessing new and curious properties. These substances, though they have never received any important application, are interesting, inasmuch as they are the precursors of gun-cotton, and furnished the germ of the discovery of that material.

In 1832 a French chemist, Braconnet, made the discovery that, by dissolving common starch in nitric acid (or *aquâ fortis*), keeping the mixture cold, and then adding water, he again separated what appeared to be the starch from the solution. But this substance was found to have undergone a curious change. Instead of burning, as it ordinarily does, slowly, with a steady flame, and leaving a carbonaceous residue, it had become to a considerable extent explosive; that is to say, it burned rapidly upon the application of flame, and much more brilliantly than when in its original condition, leaving little, if any, residue. A few years afterwards, another French chemist, Pelouze, now Master of the Mint in France, found that if he immersed common unsized paper, or ordinary cotton- or linen-fabrics, in nitric acid, also keeping the latter perfectly cool, this treatment imparted to those substances highly inflammable and almost explosive properties,

though in their appearance they were little, if at all, changed. A piece of paper operated upon in this way burns with almost explosive violence; a piece of calico burns as though it were saturated with some one of our most powerful oxidising materials, such as chlorate of potash.

The substance obtained from starch was called *Xyloïdin*, that furnished by linen or cotton was named *Pyroxilin*. The latter, prepared as just described, was obtained in an impure form; and it was not until 1846 that this substance was found by Schönbein to be produced in a much purer state by pouring cold nitric acid, or a cold mixture of nitric and sulphuric acids, upon ordinary carded cotton wool. The cotton wool appeared to undergo no change whatever; it still retained its ordinary form and appearance, feeling perhaps a little more crisp and harsh after the treatment. But it was converted into a powerful explosive substance, which Schönbein first described under the name of *gun-cotton;* a substance burning without smoke and without leaving any appreciable residue, and endowed with much higher explosive power than ordinary gunpowder.

Such a discovery as this naturally excited very considerable interest, particularly among military authorities; and experiments were at once set afloat, not only in Germany, but in France and in this country; experiments of very considerable interest and, some of them, carried out upon an extensive scale, for the purpose of determining the properties of this new explosive material.

In France, a factory was established; a considerable quantity of the material was prepared, and several of the most eminent military authorities, Piobert, Morin and others, carried on a series of most interesting experiments, the object of which was a strict comparison of gun-cotton with gunpowder. Unfortunately, these investigations, which were yielding very important practical results, and which promised before long to show clearly and definitely what was the value of this new material, were soon put a stop to by most lamentable accidents, which occurred, on two or three occasions, at or near the manufactory where this substance was being produced. Magazines containing gun-cotton, near which, it was stated, persons had not been for several days or weeks, exploded with very disastrous results; in short, the material was soon believed to be so utterly dangerous that no possible confidence could be placed in it.

In England, experiments, in the first instance of a scientific character, and afterwards of a practical nature, were instituted by chemists, gunpowder-manufacturers, artillery and other officers. Messrs. Hall, at Faversham, prepared the substance in considerable quantities; but not very long after their factory was established, a very lamentable explosion occurred there also. Large quantities of the material were ignited, it was believed (and is still, by the Messrs. Hall themselves), by the spontaneous combustion of the material, in consequence of some chemical change which it had undergone, and several lives were sacrificed by this calamity. This, of course, put a stop to the preparation of gun-cotton in this country, and since that period it has only occasionally received the attention of English

chemists, who have endeavoured to examine the substance more thoroughly. One of them especially, Mr. Hadow, has thrown more light on the nature of the substance than had previously been obtained by experiments in other countries.

In Germany, after a very short series of experiments, instituted immediately upon Schönbein's discovery, the material was pronounced to be altogether inapplicable to military purposes, by a committee appointed by the German Confederation. But, upon this committee there was an Austrian officer, Baron von Lenk, who considered the substance to possess certain valuable properties which rendered it worthy of further investigation. He continued to devote his attention to the subject, as is well known to many whom I am addressing, with varied success. At one time the material, which was again investigated by a committee appointed by the Austrian Government in 1852, was introduced to some considerable extent into the Austrian service; and experiments were carried out on its application to artillery, mining, and other purposes. Then some accidents occurred, or some discoveries unfavourable to its use were made, and it was discarded for a time. This varied success has continued almost up to the present time. A manufacturing establishment near Vienna was arranged, in 1852, for the preparation of the material on a large scale, and it is still produced there, I believe, abundantly, according to the improved system of manufacture, which is the result of Baron von Lenk's persevering labours. It is said that the material is used at the present time to some extent in the Austrian service, and that, after recent careful investigation, it is again likely to be adopted as a substitute for gunpowder for many military and industrial purposes.

About two years ago, the Austrian Government communicated confidentially to the Government of this country the general nature and preparation of gun-cotton, whereupon I was entrusted with the investigation of the manufacture of the material, and with the institution of such experiments as might suggest themselves to me, for the purpose of determining, in the first instance, whether it was really a safe material to operate with. In the course of the autumn in the same year, General Sabine, the president of the Royal Society, brought before the notice of the British Association the progress which appeared to have been made in the manufacture and application of gun-cotton by the Austrians; and a committee was appointed, consisting of chemists and engineers, for the purpose of investigating the subject. This committee placed itself in communication with the Government of this country, and also with General von Lenk, whom they invited over to meet them, and who was authorised by the Austrian Government to communicate to them full details with regard to the manufacture and the general effects and properties of the material. A preliminary report was presented by the British Association Committee at the general meeting last year, and the Council afterwards submitted to the Secretary of State for War a recommendation that a Royal Commission should be appointed to investigate the subject in all its bearings. Eventually, a special committee was appointed by the Government, consisting—partly of

scientific men, members of the British Association and Fellows of the Royal Society, and partly of military and naval men of eminence, to whom has been entrusted the examination into the manufactory of gun-cotton, into the permanence and general properties of the material, and into the possibility of applying it in the various directions in which gunpowder is used for military, naval, and industrial purposes.

This, then, is an outline of the history of the material up to the present period. Although the investigation of the subject in this country has only just been commenced, certain important and new results have already been arrived at, which throw considerable light upon the nature of the material, and also upon the uses to which it may be applied.

I shall now have the pleasure of giving you as connected an account as I can of the properties of gun-cotton, as far as we are at present acquainted with them. If you will allow me, I will first, without going into the chemistry of the matter, yet without altogether avoiding it, endeavour to make clear what gun-cotton really is. When we act upon such a substance as cotton-wool with nitric acid, which contains stored in it a large quantity of oxygen combined with the elements nitrogen and hydrogen, we bring the chemical activity of the nitric acid to bear upon certain constituent-particles of the cotton-wool. If I represent by this painted block an atom of cotton wool, and by this block a certain quantity of nitric acid, I shall be able in a simple manner to render apparent the change which the former undergoes. We have here cotton wool, composed of carbon, hydrogen, and oxygen; and here we have nitric acid, which, I say, contains a large quantity of oxygen, together with nitrogen and hydrogen. Now, when these substances are mixed together, the mixture being kept at a moderately low temperature, a certain portion of the cotton-wool is assailed by the nitric acid. The hydrogen, which is more easily oxidisable than the carbon in the cotton, is attacked by the nitric acid; a portion of it is removed from the little group of elementary atoms which form the cotton wool; and, as it is removed, a portion of the elements of the nitric acid (forming the group known as peroxide of nitrogen) enters into its place; the hydrogen that is thrown out or abstracted from the cotton is converted into water. We can go on in this way acting successively upon different atoms of the hydrogen contained in the cotton-wool; abstracting a second atom, for example, converting it into water, and introducing into its place a second molecule of the peroxide of nitrogen. By the substitution of the latter for hydrogen in the cotton, in this manner, we convert that substance into an explosive body; because we introduce a much larger proportion of oxygen into the cotton-wool than it originally contained; and this oxygen is ready at any moment, if aided by an elevation of temperature, or by other accelerating causes, to act upon the carbon and hydrogen, and convert them into gases and vapour, with almost instantaneous rapidity. In this way ordinary cotton may be converted into explosive substances, which vary in their composition and characters according to the number of atoms of hydrogen which have been acted upon. Thus, the substance obtained by the removal

of the lowest proportion of hydrogen is the least explosive, and has the same composition as the material which I described as being obtained from starch; while, by exposing the cotton to the action of a larger proportion of nitric acid, we obtain the most explosive product, the substance commonly known as gun-cotton, which has some puzzling names given to it by chemists. It is called trinitrocellulose; it is also called pyroxilin. Trinitrocellulose is the chemical term which accurately describes its composition, but "gun-cotton" will answer our purpose. We see, therefore, that this substance is produced by abstracting a certain proportion of hydrogen from the cotton-wool, and introducing peroxide of nitrogen in its place.

Intermediate between the most and least explosive bodies obtained from cotton, two other substances of analogous nature may be produced by employing different proportions of nitric acid. These substances are less explosive than gun-cotton, but more so than the starch compound, or the corresponding product from cotton. They dissolve in a mixture of ether and spirit, and produce that well-known substance collodion, which is of great importance to photographers, electricians, and medical men. I need hardly remind you that this collodion has been one of the most important agents in the development of photography. Here we have portions of cotton-wool which have been treated with different proportions of nitric acid. I am not able to distinguish between them, as they are identical in appearance, but the manner in which these substances burn will directly indicate which has been acted upon by the largest proportion of nitric acid. One is evidently the true gun-cotton; the other is the less explosive substance which furnishes collodion. We can, moreover, easily distinguish between the two by adding to each a small quantity of the mixed solvents used for preparing collodion. The gun-cotton becomes somewhat condensed by being soaked in that liquid, but the least explosive product is almost immediately dissolved.

According to Schönbein's original prescription, the cotton was to be saturated with a mixture of one part of nitric acid (of specific gravity 1·5) and three parts of sulphuric acid, (specific gravity 1·85) and allowed to stand for one hour. In operating upon a small scale, the treatment of cotton with the acid for that period is quite sufficient to effect its complete conversion into the most explosive product, pyroxilin, or trinitrocellulose. There is a small specimen of gun-cotton which I prepared strictly according to Schönbein's directions, soon after they were published in 1846. It is unquestionably pure gun-cotton or trinitrocellulose, and has undergone not the slightest change. But when the quantity of cotton treated at one time is considerable, especially if it be not very loose and open, its complete conversion into pyroxilin is not effected with certainty, unless it be allowed to remain in the acids for several hours. This accounts in great measure for the want of uniformity observed in the composition of gun-cotton, and its effects as an explosive, in the earlier experiments instituted; and it is, moreover, very possible that the want of stability, and consequently even some of the accidents which it was considered could only be ascribed to the spontaneous ignition of the material, might have been

due to the comparatively unstable character of the lower products of substitution, some of which existed in the imperfectly prepared gun-cotton.

The system of manufacture of gun-cotton elaborated by General von Lenk is founded upon that described by Schönbein; the improvements which the former has adopted all contribute importantly to the production of a thoroughly uniform and pure gun-cotton; there is only one step in his process which is certainly not essential, and about the possible utility of which chemical authorities are decidedly at variance with General von Lenk.

The following is an outline of the process of manufacture of gun-cotton as practised by Lenk. The cotton, in the form of loose yarn of different sizes, made up into hanks, is purified from certain foreign vegetable substances, by treatment for a brief period with a weak solution of potashes, and subsequent washing. It is then suspended in a well-ventilated hot-air chamber until all moisture has been expelled, when it is transferred to air-tight boxes or jars, and at once removed to the dipping tank, or vessel where its saturation with the mixed sulphuric and nitric acids is effected. The acids, of the specific gravity prescribed by Schönbein, are very intimately mixed in a suitable apparatus, in the proportions originally indicated by that chemist, *i.e.*, three parts by weight of sulphuric acid to one of nitric acid. I should explain that sulphuric acid is not used for the purpose of exerting any chemical action upon the cotton, but merely for promoting the action of the nitric acid. Strong sulphuric acid or oil of vitriol has a remarkable tendency to combine with water, and this property is usefully applied in the manufacture of gun-cotton, for the purpose of abstracting water, which the nitric acid contains, and thus rendering the latter more concentrated, and also for preventing the water, which, as you know, is produced in the chemical change, from interfering with the action of the nitric acid upon the cotton.

The mixture of acids is always prepared some time before it is required, in order that it may become perfectly cool. The throughly dry cotton is immersed in a bath of the mixed acids, one skein at a time, and stirred about for a few minutes until it has become thoroughly saturated with the acids; it is then transferred to a shelf in this dipping trough, where it is allowed to drain, and slightly pressed, to remove any large excess of acid; and is afterwards placed in an earthenware jar, provided with a tightly fitting lid, which receives six or eight skeins, weighing from two to four ounces each. The cotton is tightly pressed down in the jar, and if there be not sufficient acid present just to cover the mass, a little more is added; the proportion of acid to be left in contact with the cotton being about 10½ pounds to one pound of the latter. The charged jars are set aside for 48 hours in a cool place, where, moreover, they are kept surrounded by water to prevent the occurrence of any elevation of temperature, and consequent destructive action of the acids upon the gun-cotton. The same precaution is also taken with the dipping-trough, as considerable heat is generated during the first saturation of the cotton with the acids. At the expiration of 48 hours, the gun-cotton is transferred from the

jars to a centrifugal machine, by the aid of which the excess of acid is removed as perfectly as is possible by mechanical means, the gun-cotton being afterwards only slightly moist to the touch. The skeins are then immersed singly in water, and moved about briskly, so as to become completely saturated with it as quickly as possible. This result is best accomplished by plunging the skeins under a fall of water, so that they become at once thoroughly drenched. If they were simply thrown into water and allowed to remain at rest, the heat produced by the union of a portion of the free acids with a little water would be so great as to establish at once a destructive action upon the gun-cotton by the acid present. The washing of the separate skeins is continued until no acidity can be detected in them by the taste; they are then arranged in frames or crates and immersed in a rapid stream of water, where they remain undisturbed for two or three weeks. They are afterwards washed by hand, to free them from mechanical impurities derived from the stream, and are immersed for a short time in a dilute boiling solution of potashes. After this treatment they are returned to the stream, where they again remain for several days. Upon their removal they are once more washed by hand, with soap if necessary; the pure gun-cotton then only requires drying to render it ready for use. A supplementary process is, however, adopted by General von Lenk, about the possible advantage or use of which his opinion is not shared by others, as already stated. This treatment consists in immersing the air-dried gun-cotton in a moderately strong hot solution of soluble glass (silicate of potassa or soda), for a sufficient period to allow it to become completely impregnated; removing the excess of liquid by means of the centrifugal machine; thoroughly drying the gun cotton, thus "silicated," and finally washing it once more for some time, until all alkali is abstracted. Lenk considers that, by this treatment, some silica becomes deposited within the fibre of the gun-cotton, which, on the one hand, assists in moderating the rapidity with which the material burns, and, on the other hand, exercises (in some not very evident manner) a preservative effect upon the gun-cotton, rendering it less prone to undergo even slight changes, by keeping. The mineral matter contained in pure gun-cotton which has not been submitted to this particular treatment amounts to about one per cent. The proportion found in specimens which have been "silicated" in Austria and in this country, according to Lenk's directions, varies between 1·5 and 2 per cent. It is difficult to understand how the addition of one per cent. to the mineral matter, in the form chiefly of silicates of lime and magnesia (the bases being derived from the water used in the final washing), which are deposited upon and between the fibres in a pulverulent form, can influence, to any material extent, either the rate of combustion or the keeping qualities of the product obtained by Lenk's system of manufacture.

The gun-cotton, when thus prepared, is carefully dried and stored in well ventilated rooms, heated to about 80° Fahrenheit. This is the only operation where there is any possibility of danger. The manufacture of this material possesses most important advantages over that of gunpowder. In the manufacture of the latter, the opera-

tions are all of a dangerous character, from the moment the materials are mixed up to the final drying process; while this is the case with gunpowder, the processes to which cotton-wool is submitted for conversion into pure gun-cotton are all harmless; and it is only when it reaches the drying process that any risk of accident can occur. But if this drying process be conducted with care, the temperature of the room being carefully regulated, there is really no actual danger, even in this operation. It merely requires attention to the precautions ordinarily used in the manufacture of gunpowder, such as the exclusion of possible sources of fire, to ensure the safety of the drying process.

The question of the permanence and keeping properties of the pure gun-cotton, and, therefore, of its safety as a material to be preserved in store, or used in military or naval service, is still enveloped in uncertainty. We know that gun-cotton may be preserved for a great length of time without undergoing any change. The small specimen, prepared in 1846, which I just now showed you, is one example of the possibility of keeping gun-cotton without change. That sample was kept in a box, generally closed, and but rarely exposed to light. But here is another specimen, which I did not prepare myself, but which was given to me two or three years ago as a specimen of very carefully prepared gun-cotton. I should rather say, this *was* a specimen of gun-cotton, for the only evidence we have of the existence of that material is the presence, in the bottle, of certain products which chemists know to be formed during the spontaneous change which imperfectly prepared gun-cotton will undergo. Here, again, are specimens, prepared in 1847, by Messrs. Hall, about the time they had that lamentable explosion at their works. A quantity of gun-cotton existed in store, and they, anxious to get rid of this dangerous material, at once buried the whole quantity in a hole dug in the ground; and there it has been ever since. They were kind enough to have a small quantity dug up for me a short time ago, and this is a specimen of the material. It appears to have undergone no chemical change whatever, having been preserved in a wet or thoroughly damp condition for about 17 years. Though not the most explosive form of gun-cotton, and therefore possibly a comparatively unstable material, yet, buried in this way, it has kept perfectly well. Upon examining it by means of test-papers, and soon after its disinterment, I found that there was no trace of free acid in it. But as soon as I exposed a portion of it to light, or very shortly afterwards, it began to exert an action upon test-paper. This gun-cotton, which has been so permanent in its character for a number of years, begins therefore to change as soon as it is exposed to the light, and this change is much accelerated by the action of heat. It is found to take place, not only in this particular gun-cotton, which has been imperfectly prepared, but also in the material produced strictly according to Lenk's directions. If I expose gun-cotton in an exhausted glass globe to the action of air and light, some gaseous matter is generated; if I modify that experiment by exposing the globe to heat, which I can do by keeping it surrounded with hot water, the change takes place more rapidly and to a greater extent.

Whether this change is so important as to influence vitally the permanence of the material,—whether gun cotton, when exposed to light or heat until it begins to undergo this slight change, and then stored in the dark, will continue to decompose,—whether the changes which it may therefore undergo by travelling in limber-boxes in tropical countries, are likely to continue if the material should be returned into magazines,—these are most important points, which will require very careful investigation at the hands of the Government committee. They are naturally points of the highest interest in connection with the possible susceptibility of gun-cotton to application in warfare, inasmuch as, unless we can positively prove, without any chance of dispute, that the material is thoroughly permanent, any advantages which it may possess as an explosive agent over gunpowder will go for nothing at all.

Now, let me pass to the properties of gun-cotton, and first of all to those by which we have until lately been in the habit of recognising it. You perceive that cotton, when thus treated with nitric acid, does not appear at first sight to have undergone any change. It appears a little more crisp and harsh than the original cotton; and another indication of its having undergone some physical change, is furnished by the fact, that it absorbs less moisture. Carded cotton-wool, in its purest form, absorbs from the air about six per cent. of water; gun-cotton absorbs two per cent. of moisture. If it is dried, it speedily takes up that proportion of moisture again. If it is exposed to a very damp atmosphere, it absorbs about six per cent. of moisture; but when exposed again to ordinarily dry air, it soon loses all above two per cent. This is an important advantage which it has over gunpowder. We know that, if we expose gunpowder to a moist atmosphere, or store it in a damp magazine, it will gradually and continuously absorb moisture, until it becomes perfectly pasty; and that it is necessary again to submit powder which has become damp, to the manufacturing processes, in order to reconvert it into good gunpowder.

Gun-cotton explodes readily without smoke, and without leaving any appreciable residue. It inflames at a very low temperature as compared with gunpowder, although not at so low a temperature as was originally supposed. It is found that gun-cotton may be raised to 280 or even 300 degrees of Fahrenheit, without undergoing explosion; but these are low temperatures compared with that to which gunpowder may be heated before it explodes. I will show you the ready explosibility of gun-cotton, by introducing some, contained in this glass tube, into a vessel containing a saline solution, which is heated to a temperature of 300 degrees. You will see that the gun-cotton is in a very short time raised to a temperature at which it explodes. Gun-cotton also explodes by friction; when submitted to the friction produced by a powerful blow, it is easily ignited, with explosive violence, and converted into gaseous matter. If I take a small piece of gun-cotton, and hit it a moderate blow on this anvil, I have no doubt I shall succeed in detonating that portion of it which is immediately under the hammer, but that portion which projects beyond will remain

unexploded. Gunpowder is not generally believed to be exploded by detonation, nor is it so in the ordinary acceptation of the term. We may hit gunpowder very hard indeed on an anvil, and we shall fail to explode it, unless we happen to strike a spark with the hammer out of the anvil. In this instance, you hear that I produce a very slight detonation; and I could increase it by wrapping the powder up in tinfoil, so as to confine the heat. A short time ago, Mr. Scott Russell, in a lecture which he delivered on gun-cotton, stated and showed experimentally that gunpowder was more detonating than gun-cotton. This was a new fact to those who know what gunpowder is; and Mr. Scott Russell, in performing his experiments, must have got hold of a very remarkable specimen of that material.

Gun-cotton exhibits another curious property, one which was demonstrated just now when I showed that, in striking a mass of gun-cotton with a hammer, I do not explode that portion which is not immediately under the hammer. When gun-cotton is compressed at any particular part, powerfully or even moderately, and lighted at any other portion, the compressed part will not burn, and therefore the combustion will not extend beyond it. If I press with a card upon the centre of a piece of gun-cotton laid upon a flat surface, I can fire the gun-cotton on one side of the card, and it will not burn on the other.

Gun-cotton, in its ordinary condition, explodes much more rapidly than gunpowder. This has been evident in the one or two experiments I have already made. If I ignite gun-cotton, the flame produced is far more instantaneous in its character than that produced by the explosion of gunpowder. I may give you an illustration of the difference between the rapidity of the burning of gunpowder and of gun-cotton. I place a small portion of gunpowder on the centre of a tuft of gun-cotton, and then apply flame to the gun-cotton; if I am successful, I shall ignite the gun-cotton, and the flash of flame produced will not have time to ignite the gunpowder. Now this great rapidity of combustion constituted one of the most important objections that have been raised against the employment of gun-cotton in firearms. Although many attempts have been made at different times to modify the rapidity of the explosive action of gun-cotton, so as to render it applicable to general military purposes, only one system, and that the most simple of all, has been attended with success. By modifying the mechanical condition of the material, so as render it more or less compact in its character, the rapidity with which it explodes, in open air, may be regulated to almost any extent. If I render a piece of this tuft of gun-cotton more compact, by twisting it up between my fingers in this way, and then apply a light to it, the heat cannot penetrate so instantaneously into the small spaces existing between the fibres of the cotton, as it would if applied to the loose carded gun-cotton. You observe the great difference in the rapidity with which the gun-cotton in the two conditions burns. Therefore, this is manifestly a simple and effective method of modifying the explosive action of the material; and it is upon this simple modification of the mechanical condition of gun-cotton, that all the improvements effected in its application by General von Lenk, in Austria, depend. Instead of employing cotton-

wool in a carded condition, for conversion into gun-cotton, it is used in a loosely spun form; being converted into roving or yarn of different sizes, regulated by the purposes to which it has to be applied. Here is a large hank of gun-cotton, the cotton-wool having been, before the treatment with acids, converted into this very loose form of yarn. Having the material once in this form, we are now enabled to let it burn comparatively speaking slowly, and with great regularity. You will readily believe, from the manner in which you perceive that this piece of gun-cotton burns, that it could be accurately timed to burn a given length per second in the open air. We have here a finer description of gun-cotton yarn, and if I inflame a portion of it, you will perceive that it is a quicker burning material than the coarser and more open yarn.

The gun-cotton in this form of twisted yarn, is presented to us in a condition in which it can be converted into a variety of forms, suitable for different purposes. If we want to employ it in cannon, where it is to exert its explosive force gradually, the coarse yarn is rolled or twisted with moderate tightness round a reel or hollow cylinder of wood, the size of which is determined by that of the chamber of the gun and by the weight of the charge to be used; the best result being obtained by so arranging the latter that the cartridge entirely fills the space allotted to the charge in the gun. Similarly, small-arm cartridges are made of cylindrical plaits of fine yarn or thread, which are fitted compactly in layers, one over the other, upon a small cylinder or spindle of wood. In both of these arrangements the combustion of the charge can proceed only from the external surfaces towards the interior of the cartridge. On the other hand, the charges for shells, in which the most rapid explosion is most effective, and the priming for quick matches, which are intended for firing several charges simultaneously, and almost immediately upon the application of flame, consist of cylindrical, hollow, and moderately compact braids (similar to lamp-wicks) made of gun-cotton thread, or very fine yarn.

I will show you how rapidly the gun-cotton burns when in the plaited form, which is that employed for quick match, in shells, and for small-arm cartridges. You observe this large mass of gun-cotton is almost instantaneously converted into gaseous matter, with explosive violence. Here we have a similar plait confined in a waterproof case, in which form it is used as a quick match for mining purposes. Its combustion takes place so rapidly, that small portions are scattered without being burnt. This circumstance, by the way, constitutes one of the objections to gun-cotton, and requires to be very carefully inquired into, for the purpose of ascertaining whether the scattering of small particles by an explosion in this manner may not be a serious cause of accident in mining operations.

I will give you a striking illustration of the difference in the rapidity with which gun-cotton may be made to burn. If we take the material in the form of a tight cord, without any perforation at all, and if we introduce the cord into a case of paper, glass, or any other material, into which it fits tightly, we can make the gun-cotton burn so slowly

that it almost appears to smoulder. It is, in fact, converted in this manner into a material adapted for fuzes. By thus simply allowing the cotton to burn only at one particular point, it burns with a very great degree of slowness and regularity. I have here a small fuze made in a glass case, so that what takes place in the interior may be readily seen. I will apply a light to one end of it. You see it burns very slowly; it is only smouldering inside the tube. There is a jet of inflammable gas burning at the opening of the fuze, just as in the case of a gunpowder fuze. Thus, you perceive, we may readily employ gun-cotton for the manufacture of fuzes, if it should offer any advantages in that direction. This experiment affords a remarkable contrast to the rapidity with which the gun-cotton burned just now when in the form of plait. But I can make it burn even more rapidly than it did in the latter form, simply by modifying very slightly its mechanical condition in the interior of the tube. If, instead of using it in the form of a tightly twisted cord, fitting tightly in the tube, we insert loosely into the tube two or three pieces of the coarse yarn, placed side by side, upon applying heat to the gun-cotton thus arranged, we perceive that the explosion of the entire mass takes place instantaneously, and the result of that instantaneous explosion is the shattering of the tube into innumerable minute fragments. We see, therefore, that gun-cotton is susceptible of very great variation in its mechanical arrangement, and consequently in the rapidity with which it burns.

I should now like to investigate experimentally a few of the phenomena attending the combustion of gun-cotton under different circumstances, because they serve to throw considerable light upon the different effects which the material exerts as an explosive agent, as shown by the experiments which we have just instituted.

In speaking just now of the general properties of gun-cotton, I omitted to show you that, when it is exploded in the ordinary manner in open air, it furnishes a large body of flame, and a mixture of gases and vapour, exhibiting acid properties. The production of acid vapour by the ignition of gun-cotton, has always been regarded as one very great objection against its employment as a propelling agent in arms of any description. One of the gaseous products obtained by burning gun-cotton in the open air is exceedingly corrosive; it acts on metals very powerfully indeed. If I introduce into the vessel in which I have burned gun-cotton, a small quantity of paper dyed with a vegetable blue, that blue will very speedily become red, in consequence of the acid nature of one of the products. Another result observed when gun-cotton is burned in an open vessel is, that the first flash produced by its combustion is followed by a pale bluish flickering flame, lasting for a second or two. That flame is due to the burning in the air of inflammable gas evolved by the explosion of the gun-cotton.

If we exclude air from gun-cotton, and then inflame it, the combustion of the material will appear very different, simply because there is no air present to furnish the oxygen necessary for the burning of the inflammable gas evolved. I will just compare the effect of burning gun-cotton in air, and in a vessel containing another gas in place of air, in order to show you that this large flash of flame, when gun-cotton is burned in air,

has nothing whatever to do with the actual burning of the substance itself. Here we have the gun-cotton in two vessels; one is open at the top, communicating with the air, and is filled with ordinary air. I ask you to notice once more the large body of flame, in addition to the first flash. Here we have another vessel filled with carbonic acid gas; we have therefore excluded air, and you observe what appears to be a different kind of combustion. Again, if I burn gun-cotton in a closed vessel which originally contained air, but from which I have exhausted the latter by means of an air-pump, the gases evolved by the gun-cotton when it is inflamed by voltaic agency, are prevented from burning, because oxygen has been practically removed from the apparatus. Moreover, the gun-cotton burns very slowly indeed, because the atmosphere in the vessel is so very highly rarefied, that the gases expand enormously as they are evolved, and abstract the heat necessary for rapid combustion, as they escape from the gun-cotton. You perceive when heat is applied to the gun-cotton in this exhausted globe, we have no flash of flame, and the gun-cotton burns very slowly, appearing only to smoulder. This is, as I have said, simply because those gases generated by the decomposition of gun-cotton—not burned, but generated very slowly indeed—expand into the rarefied space, and carry away the heat which we are applying to the gun-cotton, as well as the heat developed by the combustion of the latter.

It will be readily conceived that the mechanical state of the gun-cotton (*i.e.*, the particular form in which it is employed) will greatly influence the nature of phenomena observed, when this substance is ignited in air, or in various gases, either at ordinary or diminished pressures. We have seen that when a tuft of carded gun-cotton is ignited in carbonic acid (and I might have employed carbonic oxide, nitrogen, coal-gas, hydrogen, and other gases), it burns only with a pale yellow flame; this flame, when furnished by equal quantities of gun-cotton, is much smaller in an atmosphere of hydrogen than it is, for example, in carbonic acid; a fact which must be ascribed to the comparatively very rapid diffusion of the generated gases when hydrogen is used. In operating with pieces of gun-cotton yarn, instead of employing loose tufts, the material, when ignited by a red-hot wire in atmospheres of carbonic acid, nitrogen or carbonic oxide, burns much more slowly than it does in air under the same conditions; and its combustion is accompanied only by a very small jet or pointed tongue of pale flame, which is thrown out in a line with the burning extremities of the piece of yarn. In the same way, if the yarn is enclosed in a tube or other vessel, through which those gases are circulating, and from which one extremity of the gun-cotton protrudes, when the latter is lighted it will burn in the ordinary manner only until it reaches the opening of the tube, when the form of combustion will at once be changed to that just described. If, however, corresponding experiments are made in atmospheres of hydrogen or coal-gas, the gun-cotton yarn will burn in the slow manner described, but only for a very brief period; indeed, it ceases to burn at all almost instantaneously. This result is not due to the high diffusive powers

of the gas in which the gun-cotton is burned, as it may be obtained equally in open and in perfectly closed vessels; it can therefore only be ascribed to the high cooling powers, by convection, of the gases employed. Pure nitrogen is one of the gases which allows gun-cotton yarn to burn in the slow manner, but if mixed with one-fourth its volume of hydrogen, it arrests the combustion of the material, just like coal-gas or pure hydrogen.

A rapid current of air will also effect the transformation of the combustion of gun-cotton from the ordinary to the slow form, if the yarn be enclosed in a moderately wide glass tube, with one end protruding from the tube, so that it may be inflamed in the ordinary manner; but, unless the current be very rapid, an explosive mixture of air and the inflammable gases generated from the gun-cotton may be produced in the tube, and become ignited, in which case the gun-cotton will flash into flame instantaneously, and the tube will be shattered by the explosion. If, however, I pass a long piece of thin gun-cotton yarn through this small narrow glass tube, which is about two inches long, into which it fits so loosely that it may be drawn through very easily, upon lighting it in the ordinary manner at one end, you will find that when the flame reaches the tube through which the yarn is passed, its character will change at once; it will burn in the slow manner in the tube; and when the combustion reaches the other side, the gun-cotton actually continues to burn, with the small tongue of pale flame, in the air, just as it did when I took such precautions to exclude the air. I may produce this change from the quick to the slow combustion even more simply. By perforating a card, and passing a piece of gun-cotton through the small perforation, in which it fits loosely, you will find that I can make the gun-cotton pass from one form of combustion to the other with the greatest ease; for as soon as the ordinary large flame of burning gun-cotton reaches the perforation, it is transformed into the small tongue of pale flame.

The cause of these phenomena is extremely simple; and these curious results will very likely throw considerable light on the various effects produced by the explosion of gun-cotton under different circumstances. The gun-cotton, when it is employed in the form of this thin yarn, which is laid upon a flat surface and inflamed, burns only at the one point where the heat or flame is applied. But the gases that are evolved produce a large flame by burning in the air; this flame surrounds the portions of gun-cotton which are next to be burned, and heats them to the temperature necessary for their rapid combustion. But if I prevent those gases, even for an instant, from enveloping the portions of the gun-cotton in immediate proximity to those which are burning; in other words, if I force them to escape, for a moment, only in one direction, namely, in a direct line with the burning surface of gun-cotton from which they are emitted, the latter is no longer *continuously* heated to the temperature necessary for its rapid and more complete combustion, and hence the gases themselves are in turn not supplied with sufficient heat for their ignition. Now, as the gases which escape unburned convey away a very large portion of the heat developed by the metamorphosis of the gun-cotton, it is impossible for the latter to

continue to burn otherwise than in the slow and imperfect manner. If, however, I hold a flame or highly-heated body in the path of the gases as they escape, they will at once be ignited, and the yarn will burst into the ordinary form of combustion. The correctness of this explanation may readily be demonstrated by two or three simple experiments. Thus, if a piece of loose or open gun-cotton yarn is employed, in place of the compact material which furnishes these results just described, it is very difficult, or even impossible, to cause the rapid combustion to pass over into the slow form, because the escaping gases cannot be diverted all into one direction, and cannot, therefore, be prevented from transmitting the heat necessary for perfect combustion from particle to particle of the material. Again, if I place a piece of the compactly twisted gun-cotton yarn, upon a flat surface, inflame it in the usual manner, and then direct a jet of air, by means of this glass tube, in a line with the gun-cotton, so as to meet the flame, the latter appears to be blown out, though the cotton still burns; in fact, the burning gases are prevented for an instant from completely enveloping the extremity of the gun-cotton, and hence the combustion at once passes from the quick to the slow form.

Now if, while the yarn is burning in this slow manner, I direct a very gentle current of air *against* the burning portion, so as to force back upon it the gases which are escaping, and thus impede the rapid abstraction of heat, the gun-cotton soon bursts again into the ordinary form of combustion, because, under these circumstances, the gases are almost immediately raised to the temperature necessary for their combustion. And here is one more experiment of this kind. I place a piece of the yarn upon a board, make it burn in the slow manner, and then raise one end of the board gradually, so that the burning extremity of the gun-cotton is the lowest; the latter bursts into flame as soon as the board has been raised to a position nearly vertical, so that the escaping gases flow back upon the burning surface.

I have still to show you that I can produce the slow or imperfect form of combustion of gun-cotton in open air, by applying to any part of a piece of the thin compact yarn a source of heat not sufficiently great to inflame the gases generated. A wire or metal rod, heated to any temperature between 280° F. to just below visible redness, or the spark of a thin piece of smouldering string, will invariably produce the result described. Of course, this effect, like most of the phenomena described, is to a considerable extent dependent upon the mechanical condition of the gun-cotton, and upon the relation between the *quantity* as well as the *degree* of heat applied, the amount of surface of the gun-cotton, and other conditions. While a small spark, or a thin platinum wire heated to full redness, only induces slow combustion in the compact gun-cotton yarn, a thick rod of iron, heated only to dull redness, will invariably inflame it in the ordinary manner. A piece of open yarn cannot be ignited so as to burn in the slow manner; on the other hand, the more compactly the gun-cotton is twisted, the more superficial is the slow form of combustion induced in it; indeed, the gun-cotton may be rendered so compact that it will simply smoulder in open air if ignited as described, leaving a considerable carbonaceous

residue; and the heat resulting from this most imperfect combustion will sometimes be abstracted by the escaping gases more rapidly than it is developed, so that the gun-cotton will then actually cease to burn, even in open air, after a short time.

The remarkable facility with which the effect of heat upon gun-cotton may be modified, so as even to produce results totally opposite in their characters, as exemplified by some of the experiments which have been exhibited, renders it easily conceivable that this material may be made to produce the most varied mechanical effects, when applied to practical purposes; that it may, indeed, be so applied as, on the one hand, to develope a force very gradual in its action, which may be directed and controlled at least as readily as that obtained by the explosion of gunpowder, while on the other hand, it may be made to exert a violence of action and a destructive effect far surpassing those of which gunpowder is susceptible. The results arrived at in Austria, which show that gun-cotton can be made to produce effects from three to eight times greater than those of gunpowder, cease to be surprising after a study of the chemical and physical characteristics of this interesting explosive agent.

I should like to say a few words with regard to the nature of the products of combustion of gun-cotton, this being a branch of the subject of very considerable importance.

There is no doubt that the products of combustion of gun-cotton vary in their nature almost as greatly as the phenomena which attend the exposure of the material to heat under different circumstances. We have seen that, when gun-cotton is inflamed in the open air, there is produced (in addition to water, carbonic oxide, carbonic acid, and nitrogen), a considerable proportion of the gas known as binoxide of nitrogen, which assumes a red-brown tinge, and becomes very acid when it mixes with air. The products of the different forms of imperfect combustion which gun-cotton has been described as susceptible of undergoing, are undoubtedly much more complex in their character than those just referred to. They include at times a proportion of some substances, not yet examined, which make their appearance as a white vapour or smoke; cyanogen can readily be detected in all the products of imperfect combustion; the proportion of binoxide of nitrogen is generally so large that the gaseous product becomes very highly coloured when mixed with air; peroxide of nitrogen has also been observed in some instances; lastly, there is little doubt that the products occasionally include a proportion of oxidising gases (probably oxygen.)

The products which have just been spoken of are the results either of the decomposition of gun-cotton, in air under ordinary conditions, or of its imperfect combustion under various circumstances. But when the explosion of material is effected in a confined space, in such a manner that the main decomposition takes place under pressure, the metamorphosis which the material undergoes is of a more simple and complete character.

It has been found by Karolyi that, when gun-cotton is exploded by voltaic agency in a shell which is burst by the explosion, and which is

enclosed within an exhausted chamber so that the products of decomposition are collected without danger, the results obtained under these conditions are comparatively simple; the analysis of the contents of the chamber, after the explosion, showed that they consisted of carbonic acid 20·82 per cent., carbonic oxide 28·95, nitrogen 12·67, hydrogen 3·16, marsh gas 7·24, water 25·34, and carbon 1·82 p.c.

I will try to produce before you the results of the most perfect decomposition of gun-cotton. In this stout iron sphere a small shell containing gun-cotton is enclosed, which I will explode; but, in order to do it safely, I will exhaust the air from the large sphere, and this will enable me to collect the gases produced by the explosion of the shell within. If I burst the shell, we shall know it by the production of a slight sound in the interior of the vessel. The shell is now exploded, and I allow the gases to escape through this tube. You see that they burn with a pure blue flame, indicating that the carbonic oxide produced is not mixed with binoxide of nitrogen, which gave it the green tinge in our former experiments on the explosion of gun-cotton. You shall also see that we have no acid in the gaseous mixture. I will just allow the gas to impinge for a short time upon this piece of blue paper. You may take it for granted that a long continuance of this application will produce no appreciable change upon the appearance of the paper. Lastly, if I pass the gas through a solution of salt of iron, you will see that it will produce no discolouration, while if I shake up some of the same solution with gases produced by burning gun-cotton in air, it rapidly becomes of a dark brown colour. Thus we see that, although when we explode gun-cotton in air we produce nitric oxide vapours (which become acid when they mix with air), when we explode the material under pressure, as it is exploded in practice, these acids are not produced in any appreciable quantity. It is evident, therefore, that, just as the decomposition of this material is of a more complicated and intermediate character, when its combustion is rendered imperfect by diminution of pressure or other circumstances, so, conversely, the change which it undergoes will be the more simple, and its conversion into gaseous products the more complete, the greater the pressure, beyond normal limits, under which it is exploded, that is to say, the greater the resistance offered to the generated gases upon the first ignition of a charge of gun-cotton (and consequently the higher the temperature at which the decomposition of the confined gun-cotton is effected). The notions hitherto generally entertained with regard to the very noxious character of the products of explosion of gun-cotton and their powerfully corrosive action upon metals—notions which were based upon the effects observed on exploding gun-cotton in the open air—have unquestionably been already proved to be erroneous by the results of actual application of gun-cotton to artillery, and other purposes.

There are two very important points of difference between the products of the decomposition of gunpowder and those formed on the explosion of gun-cotton. In the first place there is, practically speaking, no water produced by the explosion of gunpowder, while, in the case of gun-cotton, that substance constitutes no less than about 25

per cent. of the total products of metamorphosis. It can hardly be questioned that this water exerts functions of the highest importance in the application of gun-cotton as an explosive agent. The proportion of permanent gas furnished by a given volume of gun-cotton, in a very compact condition, is considerably less than that produced from an equal volume of gunpowder, but this difference must be far more than counterbalanced by the large volume of highly elastic vapour furnished, at the moment of the explosion, by the water formed. In fact, the heat generated by the chemical change which the gun-cotton undergoes enables the water to act as a permanent gas. Moreover, the circumstance that fire-arms, in which gun-cotton is employed do not become heated by repeated firing to anything approaching the extent observed when gunpowder is employed, must be ascribed, at any rate in great part, to the fact that the heat is principally expended, immediately upon its development, in the conversion of the water into vapour of high tension. If you recall to mind the comparatively low temperature at which gun-cotton explodes, you will realise the great importance of the fact that the fire-arm does not become heated by repeated firing with gun-cotton to anything approaching the extent observed when gunpowder is used.

The second and equally important difference between the results of metamorphosis of gun-cotton and of gunpowder is to be found in the fact that the former is completely transformed into substances which are either permanent gases, or which exist as gases or vapours at the moment of explosion. No solid residue nor smoke is produced by the explosion of gun-cotton. The serious inconveniences attending the employment of gunpowder, which arise from the fouling of fire-arms and from the dense smoke produced upon their discharge, would be altogether set aside by the substitution of gun-cotton for that material. It is asserted that there are circumstances under which the smoke produced upon firing guns, offers advantages in warfare. I will not pretend to discuss this point, but I feel sure you will admit that, in casemates, or between decks on board ship, in a naval action, it would be one of the greatest boons which could be conferred upon the soldier or sailor, if the dense, stifling, and enshrouding smoke of powder could be abolished.

The proportion of solid matter produced upon the explosion of gunpowder has been fixed at very different amounts by different authorities. According to the views of the decomposition of gunpowder which were generally accepted, until recently, war-powder of average composition, was considered to furnish from 40 to 50 per cent. of its weight of matter, *solid at ordinary temperatures.* The earlier investigators (Gay-Lussac, Chevreul, &c.) of the decomposition of gunpowder, who fixed the solid products at that amount, represented the results of the explosion of this material as being of a very simple character, and in harmony with the theory that gunpowder is converted essentially, by its explosion, into carbonic acid (or a mixture of that gas and carbonic oxide), nitrogen, and sulphide of potassium. But more recent experimentors, Bunsen and Schischkoff, who have made a very elaborate examination of the products which they

obtained by the explosion of gunpowder, represent the change to be one of a very complicated character; fix the percentage of solid substances found at from 68 to 70 per cent. of the gunpowder used, and show that the sulphide of potassium, which has been considered as the principal of these products, was only formed in very small proportion in their experiments. The conditions under which these chemists exploded the gunpowder did not, however, correspond at all in their character to those under which gunpowder is exploded in actual practice, and would, therefore, be very likely to furnish results greatly at variance with those produced when a charge of powder is fired in a gun, a shell, or a mine. That sulphide of potassium is abundantly produced upon the discharge of a fire-arm appears beyond doubt; it may be readily detected in the solid matter which remains in the barrel near the breech; it may be found deposited in considerable quantity near the muzzle of the arm, and there appears strong reason for believing that the flash of flame, observed at the mouth of a fire-arm upon its discharge, is due in part to the ignition, as it comes into contact with the air, of sulphide of potassium, which has been *vaporised* by the heat of the explosion, and is thus mixed with the escaping gases. It is well known that a red heat is sufficient to convert sulphide of potassium into vapour, and the heat resulting from the explosion of gunpowder is far above that temperature; it is, therefore, not yet proved that a considerable proportion of the products of the decomposition of gunpowder, though solid at ordinary temperatures, does not exist in the form of perfect vapour at the moment of the explosion in a fire-arm, just as the water produced from gun-cotton, though liquid at ordinary temperatures, exists as a vapour at the moment of the explosion. Mr. Scott Russell, in his interesting lecture at the Royal Institution, pronounced the 40 or 68 per cent. of solid matter produced from gunpowder to be so much "filthy rubbish," but I am confident you will concur with me, after what I have said on this subject, in thinking that this wholesale condemnation is somewhat premature; that it is necessary we should possess more definite information than now exists with regard to the nature of the products furnished by charges of gunpowder at the moment of explosion, under circumstances assimilating to those of its actual employment, before the fairness of the argument can be admitted, that certain products of the decomposition of gunpowder must be regarded entirely as waste matter, simply because they are *solid at ordinary temperatures.*

There is one more subject upon which I ought to say a few words. It is stated, upon the authority of the military committees who, in Austria, have experimented upon the application of gun-cotton to artillery purposes, that the recoil of a gun is considerably less with gun-cotton than when gunpowder is used. That such should be the case when the two explosive agents are applied to produce equal effects, (*i.e.*, to furnish equal ranges) is readily intelligible, as the weight of material used as the charge is, in the case of gun-cotton, only about one-third of that of the gunpowder employed. But, it is also stated that, in using equal weights of the two materials, the recoil of the gun is greater with gunpowder than with gun-cotton. It is impossible, in the

present state of our knowledge, to venture upon an explanation of such a fact. Mr. Scott Russell has put forward with great confidence a reason why gunpowder must produce the greater recoil. If I understand him rightly, he considers the increased reaction upon the gun to be due to the great resistance offered by, or the work done upon, the *solid* products formed on the explosion of gunpowder, which have to be projected from the gun, just as the shot or shell is. This explanation is not satisfactory to many besides myself, and an ingenious experiment which he exhibited to us a short time ago, at the Royal Institution, to demonstrate the difference in the recoil produced by the two agents, though it was very striking, as far as Mr. Scott Russell carried it out, shows, when pursued somewhat further, that this subject cannot be quite so simply and readily disposed of as he would lead us to believe. Equal weights of ordinary gunpowder and of gun-cotton in the form of coarse yarn, were successively placed in one scale of a balance, of which the other scale was loaded with a greater weight than that of the explosive. Upon igniting the gunpowder, the scale-pan which contained it was violently depressed, to such an extent as completely to raise the other over-weighted scale-pan; but, when an equal weight of gun-cotton was exploded under the same circumstances, the weighted scale-pan was hardly sensibly raised. I will perform this experiment before you with this pair of scales. The long arm or indicator of card-board, which projects in a line with the beam, from that end to which the weighted scale-pan is suspended, will, by travelling up this vertical index, enable those at a distance to observe any slight depression of the scale-pan in which the explosive is burned. Now, I will explode, successively, equal weights of ordinary gunpowder and of coarse gun-cotton yarn in the scale-pan, and you will observe the results which I have already described. But I will now ignite in the pan an equal weight of gun-cotton made up in the form of a hollow braid, and you will observe that the pan is depressed to a considerable extent; in fact the force exerted upon the loaded scale-pan was, as you saw, not very inferior to that developed by the gunpowder. Now, let me again take some of the same gunpowder used in the first experiment: I will reduce it from the granular to the pulverulent condition by crushing it with this pestle and mortar, and I will now explode in the scale-pan an amount of this equal to the gunpowder and gun-cotton already used. You perceive that, this time, the balance hardly moves; you could scarcely perceive any difference whatever between this effect and that produced, in the first instance, with gun-cotton. Just one more experiment. Here is the explosive known as fulminate of mercury, which, on the instant of its ignition, furnishes simply gases and vapour of mercury, just as gun-cotton furnishes gases and vapour of water. I will explode in the scale-pan an amount of this substance equal to only one-half the weight of the gunpowder and gun-cotton used. You will observe that the scale-pan is far more violently depressed in this instance, where we are using an explosive which furnishes no solid products, than it was when we employed double the weight of granulated gunpowder. I must refrain at this late hour from offering

any explanation of these different results; indeed, I have only made those experiments for the purpose of showing you that there are evidently other circumstances, apart from the formation of solid products, to which we must look for an explanation of what appears to be a difference in the recoil, or reaction produced by different explosives.

And now I must conclude this imperfect outline of the history of gun-cotton from its discovery to the present day. There are several other points of considerable importance included in our present knowledge of this interesting and remarkable substance, to which, had time permitted, I would have much liked to refer, but I feel that I have already trespassed too much upon your patience. I think, however, it has been made evident to you that, although gun-cotton has been known to us since 1846, we are only now really becoming acquainted with its properties and its true nature as an explosive agent.

It will, I believe, be generally conceded that gun-cotton, as it may now be manufactured, possesses several most important advantages over gunpowder. The great control which may be exercised over its explosive action; its property of exploding without producing either smoke or residue, and the safety of its manufacture, are unquestionably attributes of the very highest value in a material of the class to which gun-cotton belongs, and may combine to fulfil the expectations of its most sanguine friends. But it is imperative that we should not lose sight of the fact that, unless the stability of gun-cotton is proved by the most searching investigations to be beyond doubt, not all the advantages which are claimed for it, in addition to those which it has been proved to possess, would warrant its substitution for gunpowder in naval, military, or engineering operations.

The Chairman: I am sure I only express the opinion of all present when I say we have had a most interesting lecture. Not only is the subject itself very interesting, but the manner in which the lecture has been delivered, and in which the experiments have been performed, has added very much to the pleasure of the meeting. I may say that I once asked an eminent lecturer and professor in London, what made his experiments so very attractive. He said he always took care now and then to fail a little, because it added very much to the interest of the experiments. If experiments were always successful, he said, people would expect them to succeed as a matter of course, and they would lose half their attractions. I can only add to this, that from what we have heard to-day, it is clear that there is yet a great deal to be learned upon the subject of gun-cotton. Therefore, I shall look forward at some future time to another interesting lecture upon the same subject, when science has made further advances in this direction.

Note.—Since the delivery of the above lecture, some progress has been made in experiments instituted by me for the committee on gun-cotton, for the purpose of examining into the conditions which may affect the stability of that substance. Several French chemists of eminence have also recently been occupied with this subject, and two communications, embodying the conclusions arrived at by them, have

been made within a few weeks to the Academy of France. One of these is in the form of an official report, prepared by MM. Pélouze and Maurey, who had been entrusted by the French Government with the study of gun-cotton as prepared by von Lenk; the other is an account of the results obtained by M. de Lucca, on exposure of gun-cotton to heat, under various conditions.

The conclusion to which these chemists have been led by the results of their experiments is, that gun-cotton is not applicable as a substitute for gunpowder, on account of its being so susceptible to change as to render it liable to spontaneous ignition.

The results arrived at, up to the present time, in this country, both with Austrian gun-cotton and with material prepared in England at different establishments, according to the Austrian system, differ in several most important respects from those described in the memoirs of the French chemists. The investigation of the effects of heat, light, and of storage, under a variety of conditions upon gun-cotton, must necessarily extend over a very considerable period of time, but the data already obtained indicate decisively that the unfavourable results arrived at by the French chemists, in a comparatively short space of time, cannot be accepted as conclusively establishing such a want of permanence in gun-cotton as to preclude its application as an explosive agent.

October, 1864. F. A. A.

Evening Meeting.

Monday, May 30th, 1864.

ADMIRAL SIR GEORGE R. SARTORIUS, Kt., in the Chair.

NAMES of MEMBERS who joined the Institution between 16th and 30th May, 1864.

ANNUAL.

Brown, Frdk., Lieut. 3rd Roy. Sur. Mil., 1*l.*
Griffith, J. G. T., Capt. Royal Engrs., 1*l.*
Parry, F. W. B. S., Lieut. 22nd Regt., 1*l.*
Douglas, Sholto, Commander R.N., 1*l.*
Haslett, A. K., Lieut. Royal Engineers, 1*l.*
Kelly, J. L., Lieut. 10th Regt., 1*l.*
Magrath, J. R., Capt. R.A., 1*l.*
Trivett, J. F., Lieut. R.N.R., 1*l.*
Brown, J. H., Lieut. R.N.R., 1*l.*
Harwood, J. A. P. K., Lieut. 13th Lt. Inf., 1*l.*
Macliver, D., Lieut. 2nd Som. Mil., 1*l.*
Gibb, P. M. N., Lieut. 13th Lt. Inf., 1*l.*
Patton, H. C., Capt. 22nd Regt.
Hamersley, Jas., Lieut. 22nd Regt.
De-Cetto, M. H. E., Ens. 72nd Highlnrs.
Green, Edwd., Maj.-Gen. Bom. Staff Corps.
Anderson, Arthur, M.D., Inspector-Gen. of Hospitals, 1*l.*
Lethbridge, C., Col. H.M. Madras Army.

A PROPOSED PLAN FOR WORKING THE HEAVIEST ORDNANCE ON BOARD ARMOUR-PLATED SHIPS AND IN FORTIFICATIONS, WITH COMPLETE PROTECTION FOR THE MEN.

By Captain E. A. INGLEFIELD, R.N., F.R.S.

MR. CHAIRMAN, LADIES and GENTLEMEN,—To propose a revolution in the form of our ships of war and the method of fighting guns both at sea and on land batteries, may at first sight appear a presumption which could only be qualified by evidence of some plan more feasible, of some arrangement more comprehensive, and of advantages which will compensate for such material changes.

Now, Sir, though I cannot lay claim to the discovery or invention of such a plan, yet I have this evening undertaken to lay before your Institution two models, which purpose to combine certain novel ar-

rangements, by which guns of the heaviest description known, may be fought on board ships and on land fortifications, with complete protection for the gunners, and only a partial and temporary exposure of the gun. Of course it will be understood that in making this assertion, it is clearly with the provision that our armour plates are impenetrable, and that the walls of a fortress resist the impact of shot. These are elements of resistance which it is not part of my business to discuss this evening, though I may remark in passing, that it is not an unusual expression amongst naval men to speak of the "Warrior" as being practically impenetrable, though experiments again and again renewed, have gone to show that this far-famed vessel does not possess an armour-plated side capable of resisting the shot or even shell projected by the new experimental guns. I have, therefore, had this matter under consideration in the preparation of my plans for this new method of fighting heavy ordnance. I have endeavoured to combine an extra protection for the crew, with a certain degree of utility for the purposes of lifting the gun, and I shall presently explain to you the method by which I obtain these results.

But before entering into an explanation of the models before you on the table, it would perhaps be better to state for the information of those amongst my audience who may not be fully aware of the present position of our iron-clad navy, what are the accepted forms and build of our ships of the present day as regards their actual outline and their shot-resisting capabilities. I shall then be able more readily to explain the position which I have taken, the short-comings which I have proposed to meet, and the general advantages of a novel system for fighting guns of the largest calibre at sea and on shore.

First, exploding altogether from the category, ships of the old wooden class, I must commence with those of the "Warrior" description—vessels protected on their gun-deck and below the water-line by armour plates of a thickness considered practically sufficient to keep out the shell and shot of the ordinary sea service guns—at moderate ranges—and this armour-plate protection, with its necessary backing, in the "Warrior," actually amounts to 1,300 tons of dead weight on her outer sides; her tonnage being over 6,000.

The thickness of these plates varies in different vessels from 4½ to 5½ inches, and in the case of the "Black Prince," extends 5½ feet below the water line. Now, vessels of these huge dimensions are only constructed to carry from 30 to 40 guns, and these guns are mounted at broadside ports, reduced now to the smallest dimensions consistent with the proper working of the gun at extreme training.

In the model before you is a port made to the scale of ¾ of an inch to a foot, and indicates the exact size and proper proportions of the ports of the iron-plated ram frigate "Agincourt," now building at Messrs. Laird's yard at Birkenhead. By actual measurement and tracings obtained on the premises, these ports are 3 feet 7¼ inches in depth by 2 feet breadth on the outer side, but 3 feet 9 inches on the inner side, and they are placed 11 feet 8 apart. I am exact in stating this, as I wish to point out very particularly the area equivalent to a space 10 feet square (in a vessel having only 15 ports on a broadside),

exposed to the unobstructed intrusion of shot and shell from an enemy's ship. And when we remember the lamentable destruction of life lately recorded in the sea fight between the German and Danish ships off Heligoland, when 14 men were killed and wounded at one gun, by a single projectile, he, then, who can say that any invention which shall go towards reducing these apertures in armour-plated ships, or, still better, shut them up altogether, is not a step in the right direction, can hardly realize the frightful carnage which must be the result of a sea fight in modern days though hardly lasting half the time occupied by our ships at Camperdown, the Nile, and Trafalgar; out of which fights they escaped comparatively scathless.

Naval men have not two opinions on this subject, and hence the eager anxiety expressed amongst them as to the success of this or that gun and its projectile.

I have spoken now of what may be called the first Government form of armour-plated frigate. There are other varieties, and these are usually alluded to as vessels of the "Defence" class, or the "Hector" class, &c. It will be sufficient to add that in this latter-named vessel of 4,089 tons, the weight of armour-plates is limited to 873 tons against 1,300 tons in the "Warrior," and these tapering round the stem and stern, are 4½ inches in thickness at the broadsides.

There is still another class of iron-plated frigates to which I must make some allusion, as they appear to be gaining golden opinions for themselves from the result of their first experiments—I speak of Mr. Reed's vessels. Until that gentleman became chief-constructor of the Navy, it was deemed an impossibility to combine great speed, heavy armaments, and impenetrable armour-plated sides with a moderate tonnage; but, by the experimental vessels "Research" and "Enterprise," Mr. Reed has proved the fallacy of this supposition, for he has combined all these requirements in vessels that are termed sloops. The "Enterprise" being only 933 tons burden.

Whether these vessels, with their central iron-cased batteries, will not cause a revolution in the opinions of our shipbuilders and ship fighters, seems to be no longer a question, and much credit is undoubtedly due, not only to Mr. Reed as the chief constructor of the navy, but also to the Admiralty, who, against much opposition, singled out this talented gentleman for so eminent a position.

I have now done with iron-cased port-holed frigates, and I come to the first innovation upon the orthodox form of a vessel of war, and the method of fighting her guns; but I can hardly pass at once to a brief description of the clever invention of my friend and old messmate, Captain Coles, without some allusion to the angulated sides for ships of war, proposed by Mr. Josiah Jones, of the firm of Jones & Quiggin, iron shipbuilders, Liverpool. With an amount of patriotism and zeal seldom equalled, this gentleman has expended from his private purse a sum expressed by thousands of pounds, merely to exhibit to the world the soundness of his theory, and it is but fair to say, that the experiments carried out by the Government upon the shot-resisting targets constructed by Mr. Jones were successful as regarded the object that gentleman had in view. In what other requirements they failed for

their application to ships of war I am not in a position to state; but, together with other naval officers, I am so strongly of opinion that this form of angulated side might prove of great value for our fleet of the future, that I have constructed one side of my model to represent a vessel with angulated sides, and I believe that the day is not far distant when such a form will attract for itself the attention it deserves, and which did not elude the careful consideration of our ancestors in olden times, when they donned the pigeon-breasted steel cuirass, from which a bullet or spear would glance off, and the force of a sword blow be destroyed.

The turret or shield ship of Captain Cowper Coles must now occupy for a few moments our attention.

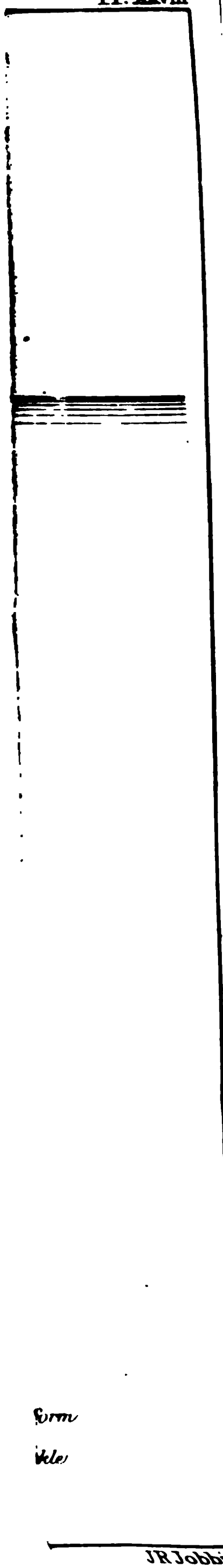
It so happened that I was one of a committee selected by the late Lord Lyons, when he was commander-in-chief of the Black Sea fleet, to examine and report upon the first proposals of Captain Coles for a gun-raft. It is almost needless to add that we were unanimous in the opinion that the invention (even in its immature form) was valuable; and we accordingly recommended that the Captain should be permitted to proceed to England for the purpose of bringing his proposals before the Admiralty. This was in the year of grace 1855, and now in 1864 the first turret-ship has not long been launched by the Government, and naval men are looking forward anxiously to the report of her abilities as a shot-resisting vessel, and what appears to be equally important, as a sea-going trustworthy ship.

Captain Coles' matured form of turret or shield-ship consists mainly in having iron shot-proof towers, which are placed amidships, and from 20 to 25 feet diameter, and which work centrally on turn-tables below the water line.

The turrets or cupolas (as they are indifferently termed) have one ormore ports of a size sufficient to ensure the proper amount of elevation and depression as regards depth, and of width with reference to the size of the gun mounted. The guns are directed upon the object to be aimed at, by moving the whole turret (which has a ratchet work and pinions below) to the proper angle, the captain of the gun looking out through an aperture in the roof of the turret to determine this angle, and give the necessary orders to the crew working the levers. When the gun or guns are pointed, they are fired in the ordinary manner, and the turret is turned away, so as to carry the ports out of the line of fire whilst the gun or guns are being reloaded. This also is accomplished in the usual manner, whether the piece be a breech or muzzle loader.

The object of the shield ship is to reduce the danger to the gun and gunners by a reduction in the size of the port and otherwise, by moving these openings out of the line of fire. And here I am bound to say, that I believe the advantage gained is great, but next, it becomes my duty to examine *at what cost* it is obtained.

First, a cupola-ship must be almost rebuilt, if it is intended to convert a ship of ordinary construction into this class of vessel. Apertures must be cut through two decks of a diameter varying from 20 to 25 feet, and this is a very serious consideration in a vessel which has



form

vele

J R Jobbins

to bear upon her broadsides such an amount of armour plating as I have stated is borne by the "Warrior;" but to this we must add, the great weight of the iron cupolas, which I cannot better illustrate than by stating that in the far-famed iron-clad Birkenhead rams (which have been for several months under my charge), the turrets weighed each 100 tons without the guns, and this in vessels of only 1,800 tons burden. Thus it will be seen that, to obtain the partial protection of the crew fighting a turret-gun, we must cut large holes in the decks of our ships, and add an amount of top-hamper to the vessel, this, not the least objectionable element in such an arrangement for a sea-worthy vessel. It is just this which seems to be the most doubtful part as regards the success of the cupola-ships, for it must always be borne in mind that be the armament, or the means of fighting it, what it may, England's marine supremacy can only be maintained by possessing a sea-going fleet; and admirable as the cupola-ships may prove for coast defence, I cannot bring my 30 years' experience in the navy to reconcile the notion that a cupola-ship in a gale of wind will behave very differently to the Agamemnon, when she was well nigh foundering with the Atlantic cable on board.

Having now generally alluded to the present construction and form of our iron-clad navy, I bring you to the arguments which presented themselves to my mind when considering the *facts* I have laid before you.

I asked myself, cannot the advantages of cupola-ships over broadside port ships be obtained by some less cumbrous arrangement than such as is set forth in the first-named vessels?

And thus I was eventually led, after much anxious thought and some experiments and calculations, to propound the plans which I now propose to explain to you, with the assistance of the models on the table.

My invention consists—

Firstly, in an arrangement by which I can dispense with the necessity for ports through which to fire guns in an armour-plated ship.

Secondly. In a peculiar method of taking the aim or laying the piece, and of loading whilst the gunners are entirely protected; that is to say, as far as the capabilities of iron armour plates will admit, and in some degree still more effectually from the effects of a bursting shell, or splinters from shot which may have penetrated the sides.

Thirdly. I claim to employ a process for lifting the gun from its place of security to its firing position, by a power, I believe, hitherto unemployed for any practical purposes.

The model before you (see Plate XXVIII, Fig. 1) represents the section of a vessel of about 1,800 tons on the scale of three-fourths of an inch to a foot, and the gun which was pointing through the port cut in the side of the vessel is a perfect model of a 100-pounder Armstrong gun upon the same scale. I now close up this port, and in doing so may remark that I propose with comparative facility to convert any broadside port ships into a vessel fitted as I suggest, without any material re-arrangement of structure.

The gun is now mounted on a carriage and platform, specially

arranged for the purposes I propose, and this will be better described, by displacing the piece and exhibiting the parts separately.

The circular platform or turn-table (Fig. 2), upon which the inclined slide is made to revolve centrally, has an inner ratchet-work, the outer rim of which is graduated, and the inclined slide is provided with a flat transverse bar or plank which extends to the periphery of the platform, and carries at either extremity a pointer which marks the angle upon the graduated platform which the inclined slide is made to assume by means of pinions when moved by a lever, causing the whole slide to revolve round the turn-table.

The carriage and gun are mounted on the inclined slide in the usual manner, the slide being so situated, that on the firing of the gun, it recoils *up* the inclined plane, whilst for running out the piece preparatory to firing, its slope renders this operation more easy.

It will be seen that the metal ways on the gun-slide are provided with a pall-plate, whilst the carriage itself has palls fitted on its fore part, and a coach spring on its rear (Fig. 3). The gun carries metal pointers firmly fixed on the trunnions; these work in a recess prepared in the gun-carriage, and are the indicators of the angle at which the axis of the piece is laid, by reference to a graduated arc let into the recess, and thus, when the indicator stands at 0, the gun is laid on a plane with the deck of the vessel, or perfectly horizontal when the ship is on an even keel. The breech of the gun is elevated or depressed by the ordinary breech screw.

I have now explained the mode of directing the gun, when the angle to the keel of the ship at which the object lies has been ascertained, and I must now ask your attention whilst I describe this process.

Through the side of the vessel (Fig. 4), at a convenient height from the ship's deck, a small orifice, for the admission of a tube of the diameter of an ordinary spying-glass, is made and fitted on gimbles. This tube is free to move in any direction horizontally and vertically, within a necessary radius. Immediately beneath this tube, and hinged to the ship's side is a graduated arc, whilst vertically a graduated bifurcated bar receives the telescope, and works in a slot on the horizontal arc previously described. It will thus be seen, that the angle at which the object lies to the keel of the vessel may be readily observed, and it is not difficult to understand, that if this graduated arc and bifurcated bar, correspond with the graduations on the gun platform and the carriage, the axis of the gun may be easily adjusted to correspond almost mathematically with the axis of the directing tube, and I wish it to be particularly noted, that with such an arrangement, and under these circumstances, the gun may be pointed and loaded at the same time.

I come now to the process of lifting the gun to a spot from whence it may be fired, and here I must state, that several methods suggested themselves to my mind, viz., by steam, manual power, or hydraulics.

The beautiful precision with which the steam-hammer of Mr. Nasmyth works, and the marvellous power which is so entirely under the command of the engineer, that he can alternately strike a blow of

10 or 15 tons, or crack the shell of a filbert without damaging the kernel, readily suggested a mode for raising a piece of ordnance which might be of the heaviest description, and yet must be elevated with precision and certainty. These were reasons why I first held a preference for this mode of accomplishing the object I had in view. The steam power, now always available on board our ships of war (and especially at a time when there would be, as in the case of an attack on a fortress, a quantity of this valuable element escaping to waste), was an inducement to work the guns of my new fashioned vessel by that power, but more mature consideration satisfied me that it would be imprudent to trust to this power alone, as in the event of its failure during an action, or its being all required for the purposes of locomotion, the armament of the ship would be placed *hors de combat.*

I have therefore abandoned, in some measure, this motive power, and though I am not without belief that by a judicious arrangement of counterpoises, the guns might be easily raised by manual labour, yet I would prefer considering this only as a substitute for the other method, which I must now describe.

When, in a ship drawing about 20 feet of water, the engineer desires to blow out his boilers, he finds that if the pressure of the steam is reduced to about 9 lbs. on the square inch, he must find some other way of emptying them; in other words, the pressure of the water on the bottom of the ship, is equal to about 9 lbs. on the square inch. Now, this is the power I employ for lifting my guns.

In the hold of the ship, I place five cylinders with pistons of a diameter and a length of stroke sufficient for the work required, and arranged with valves to admit water through the ship's bottom; always bearing in mind that as the upward stroke is made, the pressure decreasing, an excess of power is required in the first instance. Now, I derive from this arrangement several advantages over the use of steam; the motion is more steady, and each gun has its independent motor; moreover, the piece is supported upon five columns of water, and I conceive, is thus more easily sustained at its required altitude than if these were columns of steam. But I *do not* require a power equal to lifting the entire weight of the gun, for I have arranged counterpoises at the sides of the vessel, which by chains are so connected with the framework of the gun-platform that a great deal of the weight is transferred to them, and these counterpoises are by preference plates of iron, which form an extra protection to the crew, and are available for the detention of those death-dealing splinters and fragments of the modern-days shell, which all practical men declare, are more to be dreaded than the round shot, which blunders in at a port and carries itself with a whole skin through the other side of the vessel. This counterpoise of course rises and falls to correspond with the motion of the gun, and is kept in its position by several chains so as not to become useless should any one of them be shot away.

We must now suppose the gun to have been raised by the pressure of the water admitted into the cylinders to the level of the upper deck, guided securely and with precision by stout upright iron stanchions on

the fore and aft side of the platform, which has cheeks on its periphery to receive the same.

The deck is prepared for action by letting down the falling bulwarks into the recesses prepared for them in the iron-plated deck. The gun is run down the inclined plane by the crew below, the palls having been raised by a tripping line arranged for the purpose and acting with the running-out tackle. Should the object have altered its direction during the process of raising the gun, the gun can be re-directed by the crew from below, as the pinions and elevating screw have square heads on their under side which can be worked by keys. The piece is fired by the captain of the gun, who is thus enabled to look out when the object is on through his directing tube, should there be any rolling or other motion in the ship.

The gun upon firing recoils, and the shock of the discharge is greatly relieved by the powerful coach-spring which is affixed to the rear of the gun-carriage, and which abuts upon projections terminating the metal slides on the inclined plane. The valves are then turned to allow the water to escape into the hold of the ship, where it is used for the boiler-feed or injection, or into a convenient reservoir. The gun is thus gradually lowered into a place of security, and iron shutters which are constructed to slide under, and thus close up the circular aperture, are drawn into their places, and thereby the crew are protected from the effects of a shell bursting over the vessel.

I will now very briefly enumerate the advantages I propose for my new method of fighting guns.

1stly. I can convert any broadside vessel with comparative ease, and inexpensively, into a vessel to carry the heaviest ordnance on my plan—the ordinary hatchways in the deck of a ship being easily convertible into gun-apertures—and this will not interfere with their use as hatchways under ordinary circumstances, for they may still be fitted with skylights, as shown in the model, or hatches for battening down and with hatchway-ladders made to slant over the gun when it is secured below for sea service.

2ndly. I can carry the heaviest ordnance in greater numbers than a ship of the same tonnage encumbered with iron turrets, and I can place the weights as may be found most convenient, low or high, or in any middle position to suit the trim required.

3rdly. I can fight my guns with complete protection for the crew, as far as the impenetrability of an iron side can avail to exclude an enemy's shot or shell.

4thly. In case of a shot or shell penetrating the ship's side, the loose compensating plate will receive the splinters, and thus protect the men from the danger which has been remarked as so imminent whenever a shot pierces the sides of an iron-plated vessel.

5thly. The gun can be fought as an upper-deck gun entirely when exercising at a target, or at very long ranges, when the men are not exposed to an enemy's fire.

An objection might be raised as to the recoil of a very heavy gun, both regarding the concussion upon the platform and hence to the glands of the steam or water cylinders. But this model shows an

arrangement which obviates this danger. The five piston-rods are connected at their upper ends by means of a wrought iron plate, which is a counter part in form, but not in thickness, to the gun platform. Upon this the latter is entirely supported, without in any way being connected therewith, and I may add that the whole concussion of the discharge is received upon the beam-ends of the vessel.

The heavier the ordnance, it would appear the less the recoil, for, I find, upon reference to the official reports of the trial of the Horsfall gun, that with a charge of 50 lbs. of powder, and 250 lbs. projectile, at point blank range, the recoil was only 4 feet 9 inches.

In a heavy sea-way I employ an extra stanchion on the other quadrants of the platform not provided with the iron guides or upright beams before alluded to, but as these would only be required when the ship was rolling or heeling over, or in bad weather, they may be usually kept suspended to the beams overhead, as shown in the model.

It must not be lost sight of, that the gunners in both land batteries and ships, working guns on my system, are not liable to be inconvenienced by smoke; and the "din of battle" would be to them less distracting.

I have prepared a model of an iron mantelet, which may be employed to protect the gun carriage, and a gunner, should it be deemed more certain, in obtaining an aim, to take the final sight for firing from the piece itself, which can also be discharged by the same man.

I must now direct your attention to this model of a land battery. The arrangements for working the gun are identical with those I have explained in the ship model, but as the ramparts of a fortress are considerably thicker than any ship's-side, the method of laying the gun does not apply. It therefore becomes necessary, after the gun is loaded, to send up a gunner with the piece to take aim, and he takes his seat on a wooden saddle beside the gun, and from this posture he is able to look along the sights, and, assisted by the gunners below, to lay the gun at the proper angle.

I propose that in a case such as this, an iron mantelet (similar to that I have shown in the ship model) should form a portion of the traversing platform, and this will be shot-proof to shell splinters or musketry.

I must trespass a few moments longer on your attention whilst I explain the method of raising the gun in land batteries, for though I have provided this model with five cylinders similar to the lifting apparatus for the ship, I am of opinion that water counterpoises would be the more preferable method, as weight would be no object in a fortress, the balance might be so nicely equipoised, that very little manual power would be requisite to raise the gun to its required level, and I prefer tanks filled with water to be employed as the counterpoise, because, in case the enemy should succeed in effecting the capture of a gun, by turning the water out of the tanks, they would be at once placed *hors de combat*. Moreover, whenever a command of water could be obtained, the gun might be entirely lifted and

lowered by alternately supplying the tank with more water, or drawing it off.

I must ask you to remark also, that guns mounted on batteries or ramparts on my plan, have the peculiar advantage of being as easily fired upon the flank or rear, as upon the face of the work. I hold this to be no small advantage, and I am in hopes that when my plans have been subjected to the opinions of engineers, they may obtain consideration from this peculiar advantage.

When the guns are not required for service, they are placed in their lowest position, and a skylight covers the aperture, which is fitted in the centre with a funnel; this, in winter, would be used for the exit of smoke from the gunner's quarters, and would supply air at other times.

The delicate structure of modern-days ordnance, seems to demand that extra care should be taken of the guns, and by my arrangement they would be constantly under cover.

I have now to thank you, Mr. Chairman, Ladies and Gentlemen, for your kind attention to my imperfect discourse. I owe my thanks also to the Council of this invaluable Institution for the courtesy with which (upon hearing of my invention) they afforded me this opportunity of making my plans public, and I trust they will accept from me the assurance that I feel much flattered at the honour they have conferred upon me; and last, though not least, to you Ladies, for your presence, and the interest you have manifested in my discourse. This, I presume, must arise from a belief that the comparative safety of those who do battle for you and your homes, is the object of my invention, and thus wisely you agree with the sentiments of our great English Poet, who declared that, "A victory is twice itself, when the achiever brings home full numbers."

Mr. Osborne called attention to a plan which has been patented by Captain Mathews, of the Leicestershire militia, also for raising and lowering guns on a moveable platform. Some conversation ensued as to the expediency of taking the plan into consideration on the present occasion, and eventually, it was arranged that the necessary papers should be submitted to the Council for their decision, as to whether they should be read in the Institution at a future day.

Rear Admiral Sir F. Nicolson, Bart., C.B.: I do not wish to detain the meeting more than a few minutes. There are so many points connected with this invention, that I think it would be quite impossible for any officer, or even for any naval architect, and I see a very distinguished one present to give an opinion off-hand on the matter. I would suggest to Captain Inglefield that he should, when his paper is printed, give us all the details connected with it; all the measurements, of which I think we have had none this evening. We should like to know the size of all your cylinders. Could you tell us the draught of water of your ship?

Captain Inglefield: This is a model of a ship of 1,800 tons burden, drawing 19 feet of water.

Sir F. Nicolson: Where would the water line be?

Captain Inglefield: This is a model to show the principle of the thing. I confess I have not calculated more than actually to obtain the area of the cylinder to lift a certain weight with a certain pressure of water. I find the pressure of water at a height of

20 feet	would be	8·7 lb.	at the bottom of the ship.	
17 feet	,,	7·66 lb.	,,	,,
15 feet	,,	6·65 lb.	,,	,,
13 feet	,,	5·64 lb.	,,	,,

Showing the variety of pressure at different heights. I should, of course, have entered more fully into the description, only I was limited to an hour, and I was anxious to make my paper short, in order to give gentlemen an opportunity to discuss the subject if they should be inclined to do so.

Sir F. NICOLSON: That is one point. There is another point I do not quite understand; you claim that those plates, which you call the counterpoises would protect your men. But when your gun is up, the plates are down on the next deck?

Captain INGLEFIELD: They are, of course. They do not protect the men at all times; but while the gun is being loaded and the men are in motion about the gun, the counterpoises are in some measure a protection not only to them, but to the man who is pointing through the aperture. It is merely an extra protection, used as a counterpoise to the gun, and made available to catch splinters.

Sir F. NICOLSON: But when that counterpoise is down in the lower position, it does not catch splinters.

Captain INGLEFIELD: Of course, it does not then, except in case a shot should come through the lower part; but the counterpoise need not remain so low, it may be carried up on the deck.

Sir F. NICOLSON: Then, with regard to the gun itself, I presume while it is on the deck it is completely exposed?

Captain INGLEFIELD: Not completely exposed when the mantelet is on, such as I have shown here.

Sir F. NICOLSON: It will not be exposed you mean to say, because your mantelet protects it. But if I understand the arrangement, your mantelet only protects it on one side. Then with regard to the pointing, I should like to know how far as to training either fore or aft, you can point the pointing tube; because as far as I understand the thing, your pointing tube labours under the disadvantage of a broadside gun, while your gun on the upper deck by which it is pointed has a range all round?

Captain INGLEFIELD: Yes, it is so far true that the gun has a range all round; but we must always bear in mind that there are the masts and the rigging, and that though the gun bears all round, it could not be fired all round. Nor could any deck gun on a turret ship. The mantelet protects the gun in the direction of the line of fire. It may be made larger than what I have shown here.

Sir F. NICOLSON: Suppose an enemy on each side?

Captain INGLEFIELD: Then it is liable to be exposed on the unprotected side. But my claim is that the gun is only exposed for a very small portion of time; that time being while it is run out and fired; for the instant it is run in, it is lowered.

Captain JASPER SELWYN, R.N.: As an old messmate, I get up to compliment Captain Inglefield on the ingenuity and talent he has displayed in doing that which is a very novel thing, making the column of water which is necessarily displaced by the ship a source of motive power. However we may disagree from him with respect to the peculiar conditions under which he employs it; still it is a very valuable feature, and it is a novel one, which promises very considerable results. Whether the counterpoise will go on acting with exact equality under the circumstances of heeling, of course is a point open to doubt; but I have no doubt Captain Inglefield has provided sufficient surplus power for that purpose. But there is a point on which I have remarked before, with regard to the cupolas—(Captain Coles has not been here to give me an answer on that subject); and I should like to ask Captain Inglefield how the difficulty that I alluded to is got over. It is this: in all centrally placed guns, the instant the ship heels over, it is true on the broadside you may get a depression of six degrees; but on the bow and not very far on the bow, or towards the quarter, you must necessarily fire through the deck, if you want to bring your guns horizontal. It strikes me that that is a considerable objection to the employment of a very large proportion of pivot-guns as the armament of large ships. If, in the course of Captain Inglefield's answer, he will be kind enough to touch upon that point, and show how far his ship may heel over without interfering with the bow or the quarter, in pointing the gun to windward, it will be a very great difficulty set at rest. With respect to the angulated

sides, I think that feature has received its chief blow from the fact that the very heeling over brings the angulated side on the lee side, in as unfavourable position as it would be if the side were upright. At long ranges where the trajectory causes the shot to impinge on the plate at an angle, all the advantages to be obtained from the angulation are lost. Some gentlemen think the trajectory a piece of professional slang; but I think those who are accustomed to artillery will scarcely doubt that it has its effects, and that the deck is the most vulnerable point in all ships owing to that very fact. With regard to the employment of the pointing tube, I am happy to be able to relieve a brother officer of a difficulty, by drawing his attention to the fact that by means of a small prism of glass, you may deflect the ray of light coming from the object, so that a person on the main deck or the lower deck can see his object quite as well as if he were looking at it. So that the tube is not a necessity, it can be done away with. I am afraid we shall find the counterpoise liable to very considerable difficulty. It is a familiar fact to all engineers that whenever you have to deal with a moveable platform, the weights vary, the weight increasing with the upward movement and decreasing with the downward, that is to say, if having a pound weight on my hand I move it downwards with a velocity of one foot per second, I have positively subtracted from the pressure of that weight; if, on the other hand, I move my hand upwards with a velocity of one foot per second, I add to the weight. That is a consideration which is of considerable importance in all these cases, and which would lead to complications, that I am afraid would throw the counterpoise out of work. There is also, as in all these cases of supporting heavy weights on stanchions rising from the bottom, very considerable variation in the pressure due to the moveable platform from the heeling and tossing about of the ship at sea. These are considerations which would require very accurate and close calculations before we could admit that they were perfectly met. That has shown itself a good deal in the cupola ship that has been sent out, the "Royal Sovereign." They have shown that, owing to a want of consideration to that fact on the part of some gentlemen connected with it,—I beg distinctly to say that I am not referring to Captain Coles,—the bottom has bulged, and the whole of the bearings have altered.

Sir F. NICOLSON: I met Captain Osborn to-day, and asked him about it; and I assure you it is quite a mistake.

Captain SELWYN: I take the published accounts.

Sir F. NICOLSON: I pit Captain Osborn against the published accounts, and I leave it to the meeting to say which authority they will take.

Captain SELWYN: I had not heard it; and I am glad to hear it on the authority of Captain Osborn. Still I think the objection will apply, because if there is any alteration in the ship in harbour, there will be much more alteration after she has been at sea. With regard to the system as applied to fortifications, I think Captain Inglefield, when he spoke of tanks in the battery, must have contemplated getting the water from tanks at a distance. Because it would be imprudent to rely for raising your guns upon tanks in the battery which might be pierced. And as to the power of firing to the rear of forts, if that applies to sea-faced forts, I think by the time you have to fire at an enemy in the rear, you would have to get out of the fort altogether. For other forts, particularly in the nature of a martello tower, it would be a most valuable peculiarity to be able to fire landward or seaward. The application of the principle to large ships I have ventured to call in question. But I must now say that by no means do my remarks apply to small gun-vessels, which have no such protection as they require, and which must evidently have some protection when we go to war, with the iron-cased ships now forming the bulk of fleets. For I must deny that the "Enterprise" is a well-protected ship. Captain Inglefield has said it is known that no four-and-a-half inch plate is a good protection to a gun. Therefore it is folly to rely upon no better protection than this for our small gun-vessels. Moreover, a ship whose velocity may be ten knots an hour on trial, I beg leave to doubt whether she will get more than nine knots, when she gets all her stores on board. If that be so, and this vessel be a corvette, of what use would she be? The light vessels, which should be the eyes of a fleet, if we are ever to have a fleet again, should have the greatest speed. Vessels such as the Confederates have, skimmers of

the sea, may come down on your convoy and snap them up and be off again before your corvette can get near. Therefore I do not think the "Enterprise" is to be named as so satisfactory a class of vessel as some of the papers give us reason to believe. I shall be glad to see (and I have no doubt, as time progresses, that Mr. Reed will be able to give us) something much better than the "Enterprise." No one will be unwilling to recognise the readiness which he has shown to adopt improvements as they arise, and to give us some of his own. Therefore I hope some of the improvements he will in future adopt, may give us an efficient light tonnage vessel, well armed.

Commander SCOTT, R.N.: I will merely make one or two remarks. It appears to me that the introduction of that sort of machinery on board ship is out of place, for I think the heaviest gun can be worked very readily without. My own view is, that rather too much stress is laid on the disadvantage of ports, from not considering how armour-clad vessels are to be fought. Seeing that you will have very few guns in future, and very heavy guns, I think you should discharge those guns, and then sheer your vessel off slowly, and that will close the ports. If you have to raise the gun and lower it, you lose a great deal of time, just at the very moment when you want your gun to be fired as rapidly as possible in close action. At a distance, the raising and lowering of your gun certainly cannot be of much value, nor would you attempt to do it. With regard to supporting the gun, as Captain Inglefield proposes by columns of water, I very much fear whether the holes in the ship's bottom would not tend to weaken her considerably. I agree with what Sir Frederick Nicolson has said about the gun being exposed, that it is a very serious objection in a large gun. I think the closing of the apertures over the gun by shutters is not likely to be attended with good effects, because if a heavy shell fell on deck, a one-inch shutter would not keep it out, and if you had a two-inch shutter, you would have such a mass to move, that you would not be able to work it at all. In truth, the more simple you have all the things connected with naval warfare, the better. The observation Captain Inglefield made just now, about the delicate guns we are likely to have, rather confirms this. We have those delicate guns, but they have been already shown to be a mistake. Those guns are fast disappearing. No breech-loader is being made at the present time; the whole of the breech-loaders will be removed, and we shall soon have no heavy breech-loading guns at all. So that we shall have guns as simple as possible, that will stand work, and will not require any arrangement of the kind proposed to protect them.

Commander DAWSON, R.N.: I should like to ask a question with regard to the want of uniformity of pressure on the ship's bottom. I suppose there will be two or three guns mounted towards the extremities. There must be some parts of the ship being raised out of the water while others are being dipped into the water, and there will necessarily be a difference of pressure. How is that to be got over in the working of the gun? Again, I do not quite apprehend this point, when a gun is fired with great elevation, there will be a great pressure downward, which may come upon one side of the platform; and thus, it appears to me it would act upon one or two of the cylinders only. I did not catch the explanation of how that was to be got over. Another point I did not quite understand is, how the connection between the telescope and the traversing of the gun is to be kept up in the rolling and pitching motion of a ship, so as to follow the object quickly, and to communicate the wishes of the captain of the gun as to its movements, without the interposition of several second captains to read off and regulate the several elevating and training arcs. Those are the only points that occur to me at present; and I believe I am doing a service in asking these questions.

The CHAIRMAN: I have some observations to make. In a vessel of that size, with a gun of a calibre for a 400- or a 500-pounder shot, what time would you allow for raising the gun and lowering it, and for the process of loading again, lifting it up and firing it? I must express my gratification at hearing this application of a power which has never been made use of before; and which, if not exactly carried out upon the principle you have laid down, will, I think, be a useful hint that may be improved upon and applied by and by. I quite agree with Captain Scott, that when you have a heavy gun upon the deck, if you are fighting

at a distance, you will not want to lower it. Your gun will be sufficiently protected by the distance, and you will take your chance; by not being lowered down every time, you can fire a greater number of shots. Therefore, taking one objection with the other, I think the advantage of being able to fire much faster, though the gun may not be so well protected, is a greater advantage than that of lowering the gun down to load after every discharge. This remark applies to firing at a considerable distance. When you are near your enemy, then rapidity of fire is a matter of the utmost importance. I remember, in the action off Trafalgar, the ship I was on board, engaged a Frenchman. She ran aboard us with her spritsail yard into our main rigging. We had six guns on each deck to bear upon her; and it was the rapidity of the fire which changed entirely the fortune of the day. In the course of thirty-six minutes she had 434 of her crew killed and wounded, and all her masts were by the board. She came alongside us with her royals set, and in thirty-six minutes that was her state. It was the rapidity of fire that did the mischief. Fortunately ours was one of the few ships in those days in which gunnery had been very much attended to; and our men were able by their superior rapidity of fire to beat down the fire of the Frenchman. The result was, that throughout the whole action we had only about 90 men killed and wounded, while the Frenchman lost 434 men, and was disabled in thirty-six minutes. That shows how important it is to be able to have rapid fire in close action. Then, again, it is a most important object to make use of heavy guns in the simplest manner possible. I am glad to see men of your talent and genius occupying yourselves in so important a subject as that of working very heavy guns, because we certainly must come to the use of heavy guns. With guns of calibre for shot of 400 lbs. or 600 lbs. no thickness of armour-plating could ever be made that would resist such shot. I mean for sea-going vessels. Therefore it is a matter of great importance that we should be able to make use of the heaviest guns, by land and by sea, in the simplest and easiest manner. About two years ago, in a pamphlet I published, I proposed to make the ship the gun carriage, and to take up the recoil by a succession of buffer springs, and always to fire these heavy guns on a line with the keel. I believe, according to the size of the ship, you might have two, three, or four of these guns at each end, with screws at each end, and guns at each end. Of course, a new system of tactics would be required with ships of that kind. When they fight, they must always keep the bow towards the enemy, and combine the action of the ram with the guns. As this is the first time I have heard the details of the plan which you have given us, I confess that I have not quite followed them. But as a sailor, I think you will agree with me, that for the firing of your guns you cannot have the arrangement too simple. When you are very close, you must have very rapid firing; and when you are at a distance, protection is not of much importance. I must make an observation with regard to Mr. Reed. Mr. Reed has had a hard task to work. In the handiness of his vessels, he has certainly made great advances upon the former most unhandy vessels, which (as far as my experience goes) are deficient in all the material qualities which are essentially necessary to constitute an efficient man-of-war for coast service as well as for ocean service. We shall require coast service more frequently than ocean service; therefore vessels of extreme handiness and rapidity are very necessary.

Captain INGLEFIELD: I came here quite prepared for a discussion of my plans, so novel as they are. I did not expect to find all my brother officers agree with me; and I am glad to find that they have no more serious objections to urge than those which have been brought forward this evening. In reply to those questions, I will answer the Chairman first. First, with reference to what has fallen from you and myself upon the subject of Mr. Reed's vessel, I would like to explain the expression I made use of in my lecture, when I said that until the time Mr. Reed became Chief Constructor of the Navy, we had all but one opinion; naval architects and naval men believed it was only possible to have very heavy guns and very heavy armour on large ships.

Sir F. NICOLSON: With great speed.

Captain INGLEFIELD: With great speed. That, I think, was thoroughly understood. Now Mr. Reed has produced vessels that, so far as the experiments are re-

ported, have been highly successful. So I read in the official report in the public prints, and that much I quoted in my paper. Captain Selwyn has referred to the counterpoises that I employ for assisting to raise the guns. He thinks they would not rise and fall with sufficient accuracy, and that there would be a difficulty in guiding them. It is possible there might be. But I do not find there is any difficulty, however much a ship may heel, in the rising and falling of the pistons of the cylinders in the larger ships, or of the slide valves, or in the rising and falling of the sliding gear in a vessel, that rises and falls many times in a minute. Therefore I think with a suitable arrangement there would be no difficulty in working these counterpoises, which have nothing but their own gravity to keep them in their places. They might be carried in the lower part of the ship, in convenient slides and uprights for making them work exactly. Objection was made to the holes in the bottom of the ship, by which the water is to be supplied to the cylinders. But it must be borne in mind that all ships of modern times have some eight or nine holes in their bottoms, and yet we never hear of much going wrong. They are fitted with valves. These holes are employed for blowing out and supplying the boiler. And with such openings as these I would feed my cylinders by which the water is supplied to the pistons. Therefore I do not consider that any great difficulty would be occasioned on that ground. The shutters which I use for covering the aperture are not intended, like the deck which is covered with a certain thickness of iron plate, exactly to keep out a falling shell; but it is intended to protect the crew from the splinters of a shell which may burst over the aperture. Of course, if they were made of the weight and thickness of the deck, there would be great difficulty in moving them.—With reference to the pressure of water when a ship heels over in a seaway, I may reply, that if one portion of the ship is heeling over, and is thus much out of the water, the other portion of the ship is so much the more immersed. Therefore the pressure upon the cylinders would be equalised in that manner; upon one side the pressure might be greater, while upon the other it might be less. Conveyed through a table or a platform such as I have in this model, quite independent of the gun-platform, and worked in suitable slides, I consider that the gun itself would always rise at a perfect level, and that the platform would carry it perfectly truly. One gentleman spoke of the difficulty of aiming the gun, while the captain who is looking through the telescope is not actually at the breech of the gun. But I should explain, what must be familiar to most of you, that the captain of the gun does nothing himself with regard to the laying of the gun, except to look along it. He orders the handspike-men, and the men at the side tackles, "Muzzle to the right! Muzzle to the left! Elevate! Depress!" And so the captain of the gun, in this instance, will look along the tube, and will read from the arc the angle at which it should lie; and, instead of saying, "Muzzle to the right," he will say, "Two degrees before the beam!" or, "Two degrees abaft the beam!" At long ranges, I think you said, Sir George, that it would not be necessary to lower the gun. You remember, perhaps, that in my paper I said specially that when firing at a target and at long ranges, the gun might be fought entirely from the upper deck; and I believe, moreover, my gun would be applicable to fighting from the upper deck with less exposure to the crew. For I showed you by this arrangement the gun is run out entirely by the crew below; and if this mantelet is employed, the gunner may sit in a protected position looking along the gun, and giving his orders through the open aperture to the men below, who will train the gun by means of the pinions and ratchet work in the direction required. The gun upon its running in, if it is a breech-loader, may be loaded on the upper deck easily; or if the men are fighting upon the upper deck, they may load it, two men being exposed only for a moment, and retiring upon the gun being fired. Therefore I think the gun may be fired even as an upper deck gun. With regard to the advantages of a central gun or pivot gun over a broadside gun, I conceive that one point has not been alluded to, which should not be lost sight of. It is this: we are coming to a period when nothing but the heaviest ordnance can avail for our war ships. We find that ships, however thickly they may be coated with iron, and however well-protected with teak backing or iron lining, can nevertheless be penetrated. Therefore we must employ heavy guns for such work; and if heavy guns are to be employed, I do not think that they can be carried upon a broadside; that, in fact,

they must be in some position where a ship can carry in a seaway, or in a gale of wind, such an immense amount of metal as is contained in this very heavy ordnance. I therefore believe that such heavy guns must be carried as central guns. I propound this plan for carrying very heavy guns in a central position, as having the advantage of carrying half the number that I should require in a broadside ship. For clearly my guns can be fought on either side, instead of carrying a double number, which you must always do in a broadside ship.

Captain SELWYN: Will Captain Inglefield be kind enough to remember the question I asked about the bow to windward when the ship is heeling over?

Captain INGLEFIELD: I do not think that that is a question that any one is in a position to answer; for let the ship heel, place your gun as you may, you cannot fire from the centre of your ship across your bows without firing through your deck, unless you have a turret placed so high, that you can point clear of that immense range of deck.

OLIVER LANG, Esq.: I have one remark to make, viz., the lecturer has stated that all naval architects thought it impossible small sea-going ships could be built to carry armour plates, and that until Mr. Reed showed us how to do so we had no idea of anything of the kind. For myself and every naval architect I am acquainted with, I entirely repudiate that statement. The lecturer tells us the "Enterprise" is a vessel that "has done wonders, that she has attained a speed of near ten knots." Now the speed of the "Warrior" is about fourteen knots, and what chance would a vessel like the "Enterprise" have at sea with the "Warrior;" but if the "Enterprise" is designed only as a coasting ship, then a vessel could be built of the same size as her that would do everything she can do, and draw from two to three feet less water. That naval architects supposed the "Defence" the smallest size ship that could be built to carry armour plates, I entirely repudiate.

Captain INGLEFIELD: In reply, I can only say that the reports I have read of the experiments with the "Enterprise" and "Research," are such, as have led me into this error, if error it be, that they have achieved very large advantages, which had not been anticipated by naval architects and by seamen. I have had no opportunity of going out in the vessel. I have read the report from which the words, pretty nearly, that I have used myself have been quoted, that until Mr. Reed laid down these vessels, the "Research" and "Enterprise," it had always been considered that great speed, heavy armaments, and sides iron-protected far below the water-line, could only be carried in large vessels.

Mr. LANG: Then ten knots you consider to be high speed? I do not; and although I do not believe the "Enterprise" will realize more than nine knots, I give her ten; but what chance would such a ship have with one like the "Warrior," having a speed of fourteen and a-half to fifteen knots. Why *she would be out of sight in less than two hours*. It is well known that a ship that has to carry heavy weights must, if required, to attain high speed, have less displacement given by size and not by filling the fore and after ends, as with a bad formed ship it is impossible to obtain high speed, and that if ships are equally well designed, and have power in proportion, the speed of the large ship will always exceed that of the smaller one; but when the large one has a speed of fourteen and a half and fifteen knots, and the small one only ten, what chance can the latter have; it is absurd to compare the one with the other.

Sir F. NICOLSON: You used the word "official report," just now. Is it the report in the *Times* that you have read, or have you seen any other report?

Captain INGLEFIELD: I confess I have seen no other report; but this was often spoken of as an official report.

Sir F. NICOLSON: I want to explain to the meeting the value of these reports. I have had some experience of the reports under the head of Naval and Military Intelligence, which appear in the newspapers. At Woolwich I have had two years and a half experience of the accuracy of these reports, and if the meeting will be good enough to take it upon my testimony, I can assure you that they are frequently very inaccurate.

Mr. LANG: An old master shipwright who had been at Chatham a considerable number of years, told me the most surprising thing was, that when he saw anything

in the papers of which he had the means of knowing the correctness or not, he always found the report incorrect.

Commander SCOTT: Will you allow me to say one word more, as Captain Inglefield has mentioned a point which ought not to be passed over without comment; that is, as to working heavy guns on a broadside.—No heavy guns were proposed to be worked upon the broadside at all, until it was proposed in this Institution about two years ago.—The proposal was first mentioned here in 1862. But the vessels that Captain Inglefield has been speaking of, were only built to take the guns then in the service, the 68-pounders and the 110-pounders, which are not the heaviest guns. I wish to mention that, because it was in this Institution that the plan of working heavy guns on the broadside was first brought forward. If Captain Inglefield will refer to the journal, to the report of Mr. Barrass's lecture (I do not know whether it has been published or not) he will there find not only that heavy guns were proposed to be worked on the broadside, but that the means by which they were to be worked was particularly described—guns up to 24 tons.

The CHAIRMAN: With regard to the *critique* upon vessels, that, I think, is not the immediate subject of your lecture; it is the working of the gun.

Captain INGLEFIELD: Certainly; but reference is made to what I have stated. One more remark with regard to the newspaper reports, that Sir Frederick Nicolson has endeavoured to explain. I may say, and I think it is known to you all, that it is a very common thing to bring before much larger and much more important assemblies than this, the reports of the newspapers. In the House of Commons we frequently find paragraphs read and discussed from the newspaper reports. Therefore, I am not very much out of the road in having taken for granted what appeared in the *Times*, which I may perhaps qualify by calling it a semi-official report respecting the trial trip of the "Enterprise." Upon the semi-official report I based my argument. If I am in error, those gentlemen who have been in office, and who know what were the actual performances of the vessel, are far better able to give an opinion upon the subject than I am. I yield to them in that respect; nevertheless, I cannot desert the gentleman whom I spoke of before (Mr. Reed); though I have never seen him but once in my life, and therefore, he is no acquaintance or friend of mine, I believe him to be a very talented gentleman, very well adapted to the position in which Government has placed him.

Mr. OLIVER LANG: When the statement was first mentioned by the lecturer, I thought it was so foreign to the subject of the lecture, that it would have been encroaching on the time of the company had I noticed it; but when the lecturer repeated that naval architects did not know that a smaller ship might be built to carry armour plating, I thought then, that I really could not leave the room without setting him right; as it would have been thought that I agreed with the lecturer in every word he said. The lecturer tells us that he has given us these statements on the reports of the *Times*, that the "Enterprise" is a most signal success. I ask him what he conceives to be a signal success? If by a stretch I make the speed of the "Enterprise" ten knots, and if by a stretch in the same proportion, I make the speed of the "Warrior" fifteen, then I ask him whether he thinks ten knots in proportion to fifteen, a great success?

Captain INGLEFIELD: In reply to that observation, I think I quite meet the views of the Council in saying that this is not the time nor the occasion for discussing the merits of the "Enterprise," or any other ship. I therefore feel that I am not called upon to respond exactly, or to defend this vessel or that. I merely alluded to it as having read what I understood was the feeling of naval architects, and of naval men with reference to armour-plated ships of various sizes.

Captain SELWYN: As the discussion has taken rather a conversational shape, and as some points have been raised to which, as Captain Scott remarked, a reply could not be made previously, I may briefly notice a question which is a very interesting one, that of broadside guns against pivot guns, as regards the possibility of carrying broadside guns. I am totally at a loss to understand why, if corvettes like the "Tartar" can be built to carry ten 68-pounders of three tons each on the broadside, the same vessel cannot carry two ten-ton guns. It is very true the weight is more locally placed; but I conceive any naval architect will tell us that that can be met

by increasing the strength at the point which is called upon to bear it. Therefore, I do not see any very material difficulty as regards the carrying of the very heaviest guns that artillerists choose to make on the broadside of a ship, properly calculating for them.

The CHAIRMAN: If no other gentleman wishes to make any remark, we will thank you, Captain Inglefield, for the paper you have read,—for the able manner in which you have treated subjects of so much importance to the sailor as well as to the soldier. I am glad to find men of your character giving attention to matters of so much importance; and I hope they will continue their investigations. We are in a transition state. Everything connected with naval construction and artillery is a question of life or death to us. I hope the attention of both services will be called to it, and that we shall frequently have papers read on the subject with the ability and ingenuity which you have shown.

Evening Meeting.

Monday, June 6th, 1864.

CAPTAIN E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between May 30th and June 6th, 1864.

Malcolm, William, Lieut. 2nd Batt. 10th Regt. 10*s*.
Inglefield, E. A., Capt. R.N., F.R.S.
Hopkinson, William, Capt. London Rifle Volunteer Brigade.
Moore, Francis, Ensign 8th The King's Regt. 10*s*.
Fonblanque, B. A., Ensign 8th The King's Regt. 10*s*.
Sewell, T. D., Capt. Lond. Rifle Volunteer Brigade.
Hight, Edmund, Lieut. Royal Naval Reserve.
Hinton, Fredk., Major 1st Dorset Art. Volunteers. 10*s*.

ON THE DRESS AND ACCOUTREMENTS OF THE INFANTRY OF THE LINE.

Contributed by Major LYNDEN BELL, Unattached, and read by the Secretary.

WITHIN the last few years, much has been done by His Royal Highness the Field-Marshal Commanding-in-Chief, and those in authority, to improve the condition of the British soldier. Libraries, reading-rooms, gratuitious instruction, better food, and more liberal allowances of clothing, have been granted and provided; his social position has been raised, and facilities have been given, and inducements held out, to acquire education and habits fitting him for the higher grades.

For these measures we cannot be sufficiently thankful. Advancement is taking place in other directions also. No effort is spared to promote general efficiency; the divisions of the army are massed, and permanent camps of instruction have been established, by which an effective organization is kept up. Troops are now habituated to act in large bodies, and valuable experience is thereby gained, both by staff and regimental officers.

The soldier, moreover, is now armed with an excellent rifle, and taught to use it. It would be impossible to particularize each step

which has been taken in advance, but when we look back upon what *was* the state of our army, after the long peace, and compare it with the army of to-day, the country has reason to rejoice.

There is still another source of congratulation, which must not pass unnoticed, namely, that the slur which it has been customary to cast upon our Staff, will soon be (if it is not already), a thing of the past, for the Staff College sends forth a class of officers, which, in education and practical qualification, equals, if not surpasses, the standard of the "Etat Major" of any army in the world.

I have dwelt on these matters because they are encouraging to all who have the welfare of the Service at heart, and desire to benefit it, in however slight a degree, and accordingly I submit this paper, on the vexed question of the dress and accoutrements of the Infantry of the line, for charitable consideration, and shall feel glad if any part or parts of it are thought worthy of notice.

There is an old saying that "Fine feathers make fine birds," and it is applicable to the soldier. If we make him proud of his uniform, he will hesitate to disgrace it.

Smart men are, as a rule, those most to be depended on in the hour of danger, whereas the slovenly fellow, who does not care for his appearance on parade or in the streets, almost always lacks *esprit-de-corps*, and fails to be of use when he is most needed. But, as limited expense is a consideration of the highest importance, let me premise that though I would have the soldier proud of his *soldier-like* uniform, I would not decorate him unnecessarily with one extra button, or one extra piece of lace.

Chaco (See Plate XXIX, Fig. 1).—A commencement must be made, so let us take the several parts of the dress, seriatim, beginning with the chaco.

Truth to say, many improvements have been from time to time introduced in its shape and size, so that the field for reform in this particular is proportionately lessened; one evil still remains, namely, the convex peak, which, merely from the weight of the chaco, as it stands on the barrack-room shelf, becomes injured, and put out of shape.

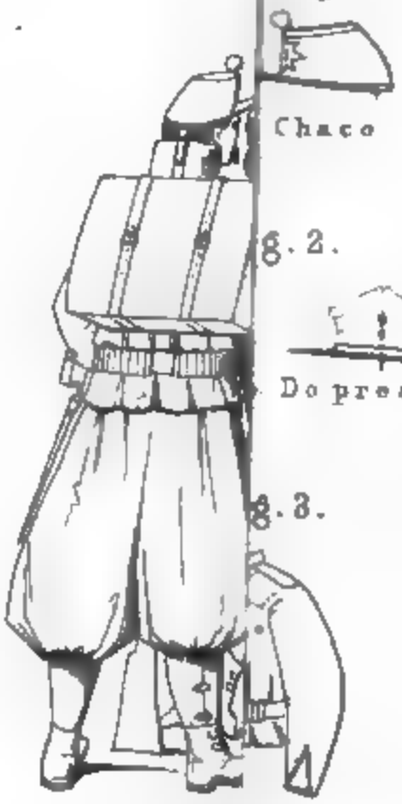
The straight peak has not this defect, and having been recognized as "regulation" in the forage caps of officers, I trust it may be soon substituted for that at present worn with the chaco of all ranks.

Forage Cap (Fig. 2).—In a temperate climate, the general efficiency of a soldier is not affected by the shape or cut of his forage cap, but as our troops serve in so many latitudes, it is wise to adopt something which is alike a partial protection from cold and heat, covering the head, and giving shade to the eyes, neither of which are effected by the regulation cap of the present date. Without desiring to go to our neighbours, the French, for every material military improvement (as has formerly been the case), we might borrow the cut of their cap with advantage. Its sides should be without stiffening, so that it could shut down flat, and the colour dark blue, regimental number worked in red.

With such a forage cap, and appropriate cover, we could (as the

Marching Order
(without Gaiters)

Fig. 1



Chaco

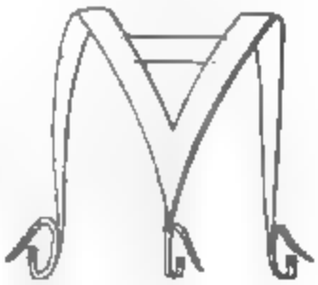
g. 2.

Do pressed down

g. 3.

Marching Order
(with Gaiters)

Fig. 5.



Ammunition Braces

Fig. 11.

igue Jacket

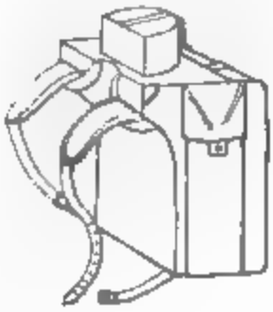
Fig 4

Make believe
Stock

Knapsack

17.

Fig. 12



The Knapsack

Fig 13.

Cap Pouch
Large Size

I R Jakhtine

Fig. 1.

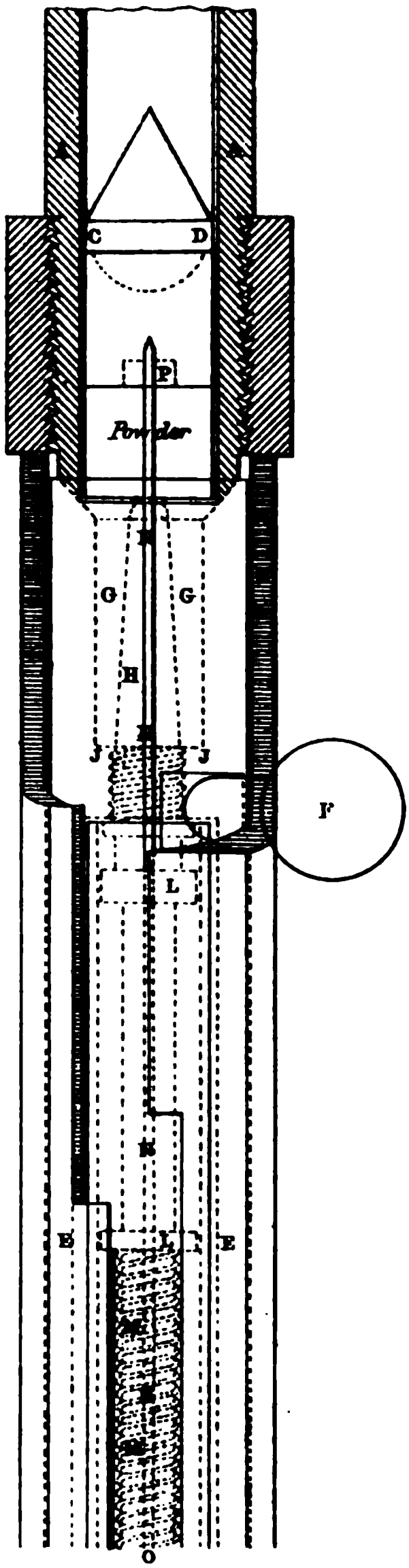


Fig. 2.

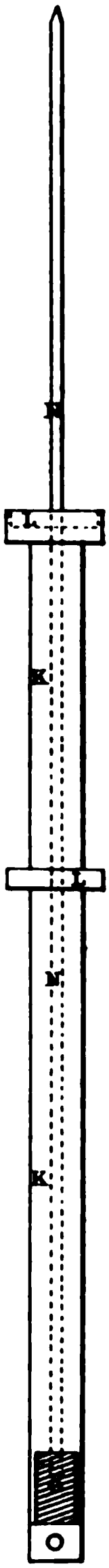


Fig. 3.

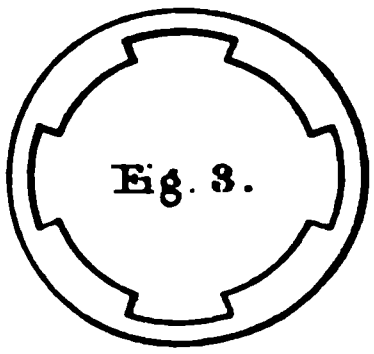


Fig. 4.

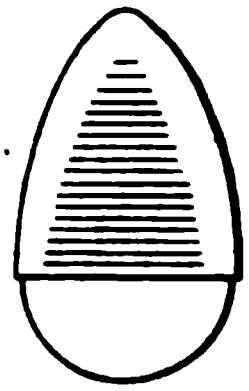


Fig. 5.

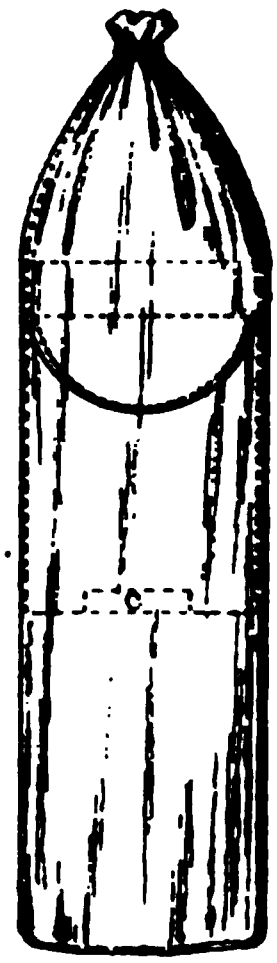


Fig. 6.

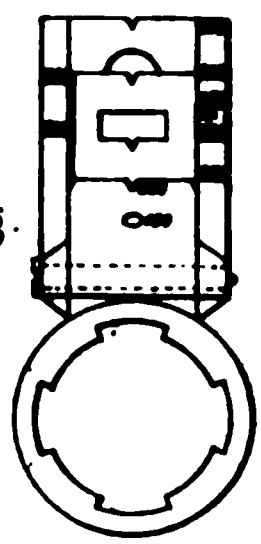
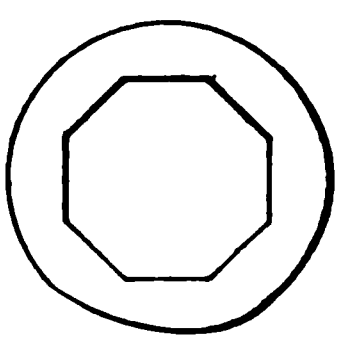


Fig. 7.



French have often done) go through a campaign in a hot climate and dispense with the chaco.

When we add a peak to our own cap, we render it ridiculous; the addition being so much out of character.

Tunic (Fig. 3).—We all cling to the memory of the good and lamented Prince Consort with kindly feelings of respect. It is to him that the army is indebted for the introduction of the tunic, and the consequent rejection of the coatee.

In the tunic, as first issued, several changes have been made, the cut, the length, and the material have been altered.

It will not then be novel if other modifications are approved of from time to time, nor, we feel assured, would the Royal Prince himself, were he alive, stand in the way of any palpable amendment.

Every day proves that the radical error in the uniforms of British soldiers taken generally, is tightness or closeness of fit, which, under the plea of giving smartness, not only robs them of ease and comfort, but impairs their general efficiency as destructive agents, and prevents them from having the unconstrained use of their limbs, either in fighting, marching, or works of fatigue.

It would be far better if a less constrained and easier style of dress found favour with those who are all-powerful in such matters, and I hope we may yet see the day when such will be the case.

The tunic which I submit for consideration, is full and loose in the body, but gathered into plaits or folds at the waist, giving freedom to the lungs, and having extra thickness round the stomach; colour scarlet, the cloth double at and over the shoulders, for the twofold purpose of keeping out rain and preventing the knapsack gear from giving uneasiness.

Colour of regimental facings as at present, bound with black cording.

There is one inside breast pocket, on the right side, but none in the skirts, which are short.

On the left breast there are two studs, firmly sewn to double cloth, for the purpose of holding the cap pocket.

The collar is very low, and as the regulation stock is highly objectionable, in that it is an impediment to the breathing, and *very* uncomfortable, I have dispensed with it, and have substituted a pliable leather lining to the collar, which shews slightly above for neatness and cleanliness' sake; the ends of this "make believe" project towards the front and cross (Fig. 4) at the throat, being fastened together by an ordinary stud, the holes for which can be cut so as to suit the thickness of the neck.

By the foregoing, we attain all that is necessary, viz., cleanliness and comfort. To continue, there are inserted under the lining of the proposed tunic, leather braces protected by padding (Fig. 5). they come out under and over the waist-belt, and sustain the ammunition, which I propose as subsequently explained to carry round the waist; at each point where the ends of the braces come out, the waist-belt is strengthened by a small piece of metal, which forms a bed for the strap, and is capable of adjustment, by sliding on the belt according as circumstances require.

Knickerbockers (Fig. 6).—We perceive that sportsmen, and men to whom money is no object when comfort is concerned, have gone back to the knickerbockers of the past ages, and found in them a garment preferable in every way to trousers, while undergoing violent exertion and fatigue.

Several of the smartest of our volunteer corps have adopted them, and find that they answer every expectation.

Let but one regiment of the line, try, and report upon them, and I feel sure they would not be condemned.

They look soldier-like, and, as with them shoulder braces are unnecessary, the restraint so imposed, and the discomfort of loss of buttons are done away with.

They can be easily sustained by a light leather strap, running through loops at the waist-band, capable of being tightened or the contrary.

The colour which contrasts most favourably with a scarlet tunic, is dark blue; but tartan, for Scotch regiments, would look very well; let there be a broad red stripe down each side, and the fastening at the knee a leather strap and buckle; and give them an ample pocket at each side.

Each man should have a pair of blue cloth for winter, and of blue serge or some other blue material for summer, and for change, flannel in the tropics would be suitable.

Hose (Fig. 7).—Dark grey or heather-coloured hose would accord well with dark blue.

There is one point which strikes me in mitigation of expense, viz., that as the foot of the hose or stocking is the part most exposed to wear-and-tear, the foot part and leg part should be complete in themselves, and joined together by sewing; this would give the means of adding a new foot to the leg of the hose if the former was worn out, and no ravelling of the worsted would take place.

In hot weather, and on the line of march, when not necessitated by wet, the hose should be worn unprotected; but for night-work, or otherwise, a light, waterproof, canvas legging, bound with self-coloured leather, and fastened by three buckles and straps, would keep out rain, wet, and cold (Fig. 8).

The Ammunition Boot (Fig. 9).—We have descended gradually from the chaco to the boot; but in considering these subjects, their importance increases rather than diminishes; for, whereas an ugly chaco (though unsightly) does not impair general efficiency, it is imperative that the soldier should have a good boot.

That submitted for adoption, is fastened by two strong buckles and straps, so as to give neatness, by admitting of extension or compression according to the size of ancle, and height of instep; the soles are made to project beyond the uppers, and the heels are low and broad.

The "*string system*" now in force in the boots of the infantry, is untidy, and uncomfortable, and does not afford support to the ancle.

A man with well-fitting boots feels more active, his step is more elastic, and he is capable of marching with less fatigue, than when he

is encumbered with such as are loose, misfitting, and wanting in identity with his foot.

Shirts (Fig. 10).—"Flannel next to the skin" is a preventive against pulmonary complaints, and many other "ills that flesh is heir to."

Whether the climate be warm or cold, it is equally useful; in the former, it prevents the checking of perspiration, and in the latter, it keeps the wearer warm. Men exposed to such vicissitudes, and to night air, as soldiers are, require every protection that can be afforded to them; and the average mortality being so much greater in the ranks of the army than in civil life, it would be true economy to try all feasible means to lessen it.

One step in the right direction would be gained, if flannel shirts were given to the duty soldier of the line; the necessity is recognised for the volunteer force, at pages 72 and 73 of the Regulations affecting them.

One soldier lost, is more to be deplored, taking the matter in a low, pecuniary sense, than the outlay of very many flannel shirts.

Our army is small, and the nation whose honour it is called on to support is great and rich. If there *be* extra expense, is not it well that it should be incurred in such a cause and with such an end?

Even two flannel shirts would be sufficient to meet the emergency; both could undergo inspection on the day that the clean one came from the wash; and on service the soldier could wash his own, thus having a change at all times in his possession; but give him three if necessary.

The flannel shirt of a soldier (particularly as I advocate it to be worn with knickerbockers) should be of more than ordinary length behind, and might then fasten by buttons or strings to the front, and prevent the chafing which is so liable to occur on the line of march.

Fatigue Jacket (Fig. 11).—The design of fatigue jacket submitted is looser and longer than at present; the collar is leather, lined in the manner described in the remarks on the tunic, facings the same, colour scarlet, fewer buttons, loose sleeves, and plenty of room in the shoulders.

When we see the caricatures of our men by the French, under title of "Types Militaires," we must be struck with the absurdity of the *shell* jacket, and the idea thus presented is confirmed by practical experience, namely, that as a garment, it requires the *smallest possible piece of cloth in its office of encasing the body.*

Accoutrements and Appointments.—Let us as a commencement do away at once and for ever with *pipe-clay*, removing that stigma *practically* from the soldiers' belts, pouches, straps, slings, &c., as it is being gradually removed, in a theoretical sense, from all other matters connected with well-being and discipline.

Those in favour of pipe-clayed belts, on the ground that they look well on parade, should turn to the reverse of the picture, and see them on active service in the field, exposed to rain and mud; they should remember the experience of the Crimean campaign, and the appearance they presented then in the smartest of our regiments. Nothing indeed could be more different, and nothing could be more dirty than they

were. The men can hardly be blamed by the strictest disciplinarian for this natural result; they were constantly employed at one duty or other, they had not time even to rest. The "*Buff*" requires too much of this time to get it up to the parade mark. In winter, the weather was too inclement to dry the belts (if any attempt was made to pipe-clay them), and it was indeed lamentable to see the once clean soldier of England with nothing of his pipe-clay left; his filthy belts showing how unserviceable they really were, and how unlike what they ought to be.

Leather belts, straps, and slings, of their natural colour, on the contrary, do not suffer a similar fate on service, they *are* what they seem to be, there is no such fall from great show to abject dirt. They are always ready, they do not require so much care, time, and trouble, and consequently *afford* more time for that *great essential—rest*, and for the important duties of the camp. Little beginnings very often lead to great results, and even the dirty once pipe-clayed buff belt may discourage the clean soldier of former days, give excuse to the slovenly fellow to be more dirty still, and thus affect the "morale" of all.

To proceed, I have, as a general rule, introduced plain buckles and straps whenever a fastening of the kind is required in the knapsack, belts, or accoutrements, such being to my view the simplest and readiest method of attaining the end sought.

The Knapsack (Fig. 12).—The part of the soldier's equipment which it is most difficult to provide in a perfect form, is the knapsack.

In considering it, several points seem to present themselves as essential:—

First. That the weight should be so disposed, as to be sustained by those parts of the human frame most capable of bearing it.

Second. That it should be easy to the wearer, and possess identity with his movements, without cramping the action of his limbs, or pressing upon the lungs, or any other vital part in an injurious manner.

Third. That it should be sufficiently large to carry all required for a short campaign, without being objectionably heavy.

Fourth. That it should be capable of being taken off and put on again by the wearer without difficulty or loss of time, so that advantage may be taken of any temporary halt to enjoy the rest and relaxation of being without it.

Fifth. That the cost of making it should be limited to a small sum.

How many of these conditions are filled by the Regulation knapsack?

Partially it fulfils point No. 3, but its fittings are incomplete and complicated; it does indeed cost but little, and so provides for point 5; in other respects it is wanting; for although its weight is raised to the shoulders by means of the "stick," and it now no longer falls into the hollow of the back (as a very smart officer of my acquaintance used to say), like a "tinker's wallet," yet the pressure of the stick on the vertebræ of the back near the neck, is very unpleasant indeed.

Military men know by experience, that rarely is the soldier found who can take off and put on a full pack unassisted. It requires the

kind offices of a comrade, who in his turn needs the same; consequently men prefer keeping the burden on to taking it off, when the halt is only temporary, the trouble outweighing the advantage in their eyes. Such being the case, it is too clear that there is much room for improvement.

In the pack now presented for consideration, I have begun by taking it as a rule, that if we conform to the natural curve of the back, neck, and shoulders for those parts which come in contact with them, we secure more of ease and "identity" than is the case when we strap a plane surface to a curve.

Thus the inner side of the knapsack (that is the one next to the body) is curved as it approaches the shoulders, and projects in fact over them, the shoulders and collar bones being protected by padding on the inside of said projections. Having thus secured a base on which to build, viz., the shoulders (which are most capable of sustaining weight), we can raise the knapsack two or more inches.

Supposing us to be looking at the side of the knapsack, the curved line of projection above mentioned takes a course inwards, following the ordinary upward slope of the shoulders, and a passage for the neck is hollowed out, after the fashion of the yoke by which milkmen support their cans (see Fig.).

Having so far brought the pack partially over each shoulder, without hindering the free action of the neck, the next step is to secure it to the body, and keep it in the desirable position attained. To this end, broad padded springs, in continuation of the curve, and holding the pack to the body as required (without being too strong to press injuriously), are affixed to the shoulder projections at an angle which inclines inwards and upwards, conforming to the slope of the shoulders.

The pack prior to issue, can be fitted to each soldier, and the springs then screwed on to suit the breadth of shoulders.

At this stage we have the knapsack secured to the body, and kept in the position desired, with the weight disposed on the strongest parts of the frame, but in order to prevent its coming off when moving rapidly, performing the bayonet exercise, or when fighting, straps are provided; the right strap when once adjusted need not be altered, except when the knapsack is worn over the great coat.

At the termination of each spring pad, there is a ring, and to these rings that part of the straps terminating in the "tongue" are attached, the corresponding portions having the buckle being in the same manner permanently fastened to the lower corners of the pack. On the right side, the position of the buckle is under the arm, near the lower corner of the knapsack, and does not interfere with the butt of the rifle in firing. On all occasions the man is intended to slip his right arm through the loop when putting on his pack, just as one would put on a coat.

On the left side the portion of the strap having the buckle is longer, and the fastening is in such a position (viz., about midway) as to enable the right hand to adjust it easily.

It will be observed, that these straps from the relative position of the rings attached to the lower part of the spring pads, and the

bottom of the pack, which are their respective terminations, cannot cut the soldier under the arms, and are indeed more for the purpose of restoring the balance, if lost, than resisting pressure.

On the sides of the knapsacks are elongated pockets, one to hold three pieces of wood, which fit together like a fishing rod, for the formation of the pole of a *tente d'abri*, and are not much thicker than a walking stick; total length of four such pieces being about 3½ feet; on the other side three light tent pegs and a piece of thin rope, about two yards long, to act as a stay for one of the tent poles. At the back of the pack, in addition to the great coat, are two pieces of light waterproof canvas, fitted with eyelet-holes and strong cord, and capable of being tied together (with an overlap to prevent rain entering), and form one side of the tent, or of separately acting as a cover for the ends of it, according to circumstances. In this manner any three soldiers could form an effective shelter from rain or dew.

It is barely necessary to point to the advantage of having a *piece of waterproof always in possession* on a campaign. Even when encamped in the regular ordnance tent, the waterproof sheet could be used, if needed, to lie on, and prevent or mitigate the evils arising from the exhalations of damp ground.

In many cases when *tentes d'abri* would be used, a considerable number of men would of necessity be on duty, and more room would thus be afforded to those left to occupy them.

It may be remarked that I have left the blanket out of consideration in the foregoing observations, but as we cannot overburden the soldier, a choice must be made between the blanket and a section of the *tente d'abri*. Let us consider their respective advantages.

After a night of rain, the soldier with a *tente d'abri* would commence his march in dry clothes, whereas with the blanket only, he would be saturated with wet; any advantage arising from the warmth [illegible] would be rendered null and void by the damp. He must [illegible] his active duties carrying a wet blanket (which is no slight weight,* and days and nights may pass without its becoming dry again. A wet blanket is of no service, but rather the reverse.

I have too much faith in the improved organization of our army, in respect to the military train, to doubt that there are very few [illegible] stances which could arise to prevent the blankets [illegible] could be [illegible]. They could be served out after the [illegible] handed in at reveille.

The time and trouble [illegible] embarrass a flying [illegible] a blanket for each [illegible] never to do so.

[illegible]—[illegible] it holds the [illegible] because [illegible] cartridges only.

[illegible]—A [illegible]

* [illegible]

either in quarters or in the field, but such nevertheless is the case. On home service there is no means by which infantry can carry a supply of water to refresh them on the line of march, or during a field day.

When an army prepares to take the field, water kegs are served out, but no drinking cups.

The "water keg" is clumsy and heavy, it is only necessary to look at it and be convinced of the fact; whereas the "bidon" (Fig. 14), is complete in all that is required.

If the men had the means of carrying a supply of water on all occasions, when in "marching order," much "falling out" and straggling would be prevented.

The Haversack (Fig. 15).—To be of real benefit the haversack ought to be *waterproof*, it would then keep provisions, and (on a pinch) reserve ammunition dry; *now*, being only a common canvas bag, it, of course, cannot do so, and the contents, of whatever nature, suffer from exposure to rain.

The haversack, of which I submit a sketch, is waterproof; it is much shorter; there is a moveable calico lining, for the sake of cleanliness; it is intended to carry the knife, fork, and spoon, and extra ammunition, if required.

Ammunition Belts and Pouches (Fig. 16).—When a regiment moves in "double time," almost every man who can escape detection puts his hand to his pouch, to prevent the incessant and painful bumping which the acceleration of pace causes.

The weight of the cartridges, confined to a small space, falling and rising again at each step, has most injurious effects, either interfering materially with freedom of movement, by taking (as I have observed) a hand to keep the pouch steady, or (if the hand be not used) causing actual pain to the poor soldier, and making him glad indeed to drop into a walk.

From the above, we argue that the weight of the ammunition is not now disposed in such a manner as to favour rapidity of movement, the necessity for which is becoming more and more apparent.

Happily *gymnastics* have at last been introduced, and it is intended to cultivate in future the muscular powers of our men which have hitherto been neglected, and to promote emulation in feats of activity and strength, it being well known, that quickness of manœuvre and concentration on decisive points, are winning tactics, and that the relative power of armies, equal in efficiency in other respects, are in the ratio of their strength, multiplied by their rates of marching. Therefore if we can move more rapidly we increase our power, in order to do so, however, we must first take away the drawback alluded to.

To further this object, I submit the following, viz. :—

A plain strong leather waistbelt, passed through the three loops formed by the braces (see remarks under the head of "Tunic"), supported by them, and strengthened at three points.

This waistbelt is fastened by a buckle and tongue, and can be tightened or loosened at pleasure. Upon it are four close-fitting, long, pliable, 15-round pouches, which are each secured by two close spring

Major-General Boileau, R.E., F.R.S.: In reading this paper, I beg to observe that I am only acting as the mouth-piece of Lieutenant Walker, Assistant Instructor of Musketry at Fleetwood, who cannot be present, and I have, therefore, to premise that I am not answerable for any of the opinions expressed.

BREECH-LOADERS FOR THE ARMY, AND GUN-COTTON AS AN EXPLOSIVE AGENT IN MODERN WARFARE.

By Arthur Walker, Esq., Lieut. 79th Highlanders, Lieut. Instructor School of Musketry, Fleetwood.

The announcement recently made in the House of Commons by the Marquis of Hartington, that two thousand breech-loaders were to be placed in the hands of the troops, to be tried and reported on, will, we believe, be received with unmixed satisfaction by the public in general, and the army in particular. The conviction is fast gaining ground amongst all classes, that the breech-loading system, in some shape or other, must, before very long, be adopted for the army of England.

It will be observed, however, that the step in the right direction taken by the Government is merely one of a tentative character; and therefore, whilst it is still under consideration, and pending the inevitable "report" sooner or later to be sent in, it may not be inopportune to seize the present moment for ventilating some of the important points which the recent course of events has developed or brought to light with respect to breech-loaders as a *military* arm.

It is almost superfluous to remark, that with the exception of Prussia and a few special corps in other countries, breech-loaders have not been introduced into the armies of Europe; and therefore, if we would learn something as to how breech-loaders work practically as military weapons, we must go to Prussia for our information.

The "*Zundnadelgewhr*" or needle rifle, called so from the ignition of the charge being produced by a needle being passed through the cartridge to strike the percussion powder, was introduced into the Prussian service in the year 1848, and the following may be regarded as a correct and comprehensive description of this fire-arm.

* "The barrel, AA, (Fig. 1, Plate XXX), which is 34 inches long, is rifled with four grooves (Fig. 3), and has a "hausse," or sight, adapted to distances of 600 metres. It is screwed into the end of a strong open guider or channel BB. The chamber, properly so called, is bored out

* Vide Sir Howard Douglas's work on Naval Gunnery, 5th edition, p. 560, et seq., whence Figs. 1, 2 are taken.—A. W.

from behind, conically in a slight degree, so that, when the cartridge is placed in it, the shoulder, CD (Fig. 1), of the ball shall meet and be stopped by the projections or ribs of the rifling, the body of the shot being of sufficient diameter to fill the full depths of the grooves. Inside of the guider slides an iron tube, EE, with a strong "hebel" or handle, F, and having at the front end a space, GG, of about 1½ inch in length. In the middle of this space is a "tige" or pillar, II, which, instead of being solid like that of a pillar-breech musket, is pierced with a small hole in its entire length, and through this passes the needle N, which is to ignite the charge: the steel tige is screwed into a solid plate of iron, JJ, left in the tube EE, and this plate it is, which (like the breech-pin of the ordinary musket) receives the whole reactionary force of the charge."

"Behind the plate, JJ, there is a second tube of iron (which could not be shown in the drawing) having a double catch spring attached, and carrying within it a small inner tube of iron, KK (Fig. 2), having two projecting rings, LL, on one moiety of its length, and a spiral spring, MM, (Fig. 1,) sliding on the other half. Through the tube, KK, passes the needle, NNNN, which is a thin steel wire about ·03 inch diameter, bluntly pointed at the end, which is to ignite the charge; at the other end it is screwed into a brass head, O, and this again screws into the inner tube, which carries the spiral spring. The trigger, which is of a peculiar form, and has a bolt movement in firing, could not be shown intelligibly in the diagram."

"At the lower part of the barrel is the sliding tube through which passes the needle for igniting the charge. This tube is capable of being moved backwards or forwards in the barrel near the breech by means of a pin, or handle, in its side, which passes through a perforation similar to a bayonet notch in the side of the barrel. When the tube is drawn as far as the perforation will allow towards the stock, there is formed an open chamber between its extremity and the nearest extremity of the barrels and by means of this chamber the charge is introduced into the barrel. The tube is then pressed forward till its extremity, which is in the form of a frustum of a cone, is in contact with the rear extremity of the barrel; this extremity having the form of a hollow cone to receive the end of the tube; the pin or handle being then turned round in the notch, the tube is, as it were, locked in close contact with the barrel. In this state the needle in the tube is in connection with the trigger of the lock, and the musket is ready for being fired."

The grooves shown in Fig. 3 have a uniform depth and twist, with one turn in 42 inches. The bullet is ogival in form (Fig. 4), and weighs 451 grains, and is fired with a charge of 65 grains of powder in the cartridge. The powder is separated from the bullet by a rolled and compressed paper cylinder, which is hollowed at the end next to the bullet, so as to fit the base of the bullet (Fig. 5). It has also a cavity at C, in which is lodged the fulminating composition to be exploded by the needle driven into it—thus avoiding the use of caps, priming, &c. The elevating sight (Fig. 6) is in part fixed and in part moveable; it is lowered in its position on the barrel either to the front

or to the rear. The cost of the gun is not great, being only between 12 and 13 thalers, or from 36 to 39 shillings English.

The salient properties of the needle-gun may be taken to be the following:—It can be loaded and fired six or seven times in a minute, more or less, according to the skill and dexterity of the soldier. Of course this does not suppose and include time for a careful aim; but when firing into masses, at short distances, very little aiming is required, owing to the flatness of the trajectory on such occasions. All that the Prussian has to do, is to open the lower end of his rifle-barrel—which is done by a most simple contrivance—to take a cartridge from his pouch, which he wears in front instead of behind, insert it without biting or breaking, shut to, and fire. There is no ramming down, which exposes the man when in front of the enemy; no fumbling with tiny caps, hard to feel with cold fingers, but everything is simplified and well-adapted to the desired object.

It has been objected by military men that this kind of gun would easily get out of order; but according to the correspondents of the newspapers, the Prussian officers, who in time of peace always stood up for the excellence of their weapon, are more than ever satisfied with it now that it has been tried in war. The soldiers do not treat it as if it were a very delicate weapon, but, on the contrary, knock it about in loading and handling, quite as much as it would be proper to do with any other kind of rifle.

By a singular coincidence, the field in which this breech-loading rifle was first practically tested was the same as that in which it has recently asserted its terrible destructiveness; and although in the former abortive war between Prussia and Denmark this was not perhaps developed to the same extent, yet the bloody battles of Kolding, Fredericia, and Ilstedt attest only too fully the deadly effect of its fire. At the latter engagement, it is related, that in seeking to dislodge some Prussian infantry from a bridge, the Danish infantry and cavalry were, in a very short time, nearly decimated; the General in command was struck down, the chief of his staff wounded, and nearly every other officer either killed or wounded in less than an hour.

Since the period in question, no effort has been spared to improve and develop the advantages of the needle-gun, and during the Crimean war one million thalers, or £200,000 were voted by the Prussian Chambers, in excess of the preceding year's expenditure, with the view of extending its manufacture and securing its issue to every soldier in the Prussian army.

The wisdom of this forethought on the part of the Prussian Government, and how this formidable armament has succeeded, may be gleaned from the various accounts which have reached us of the Sleswig-Holstein War, the din of which is still fresh in our ears. From the very first, whenever the Prussian and Danish infantry came into collision, and especially when these encounters took place between masses in the open field, during this deplorable war, the disparity in the losses has told fearfully against the Danes—to an extent, indeed, that at first appears wholly unaccountable. Observation and inquiry, however, soon demonstrated that this disparity was entirely attri-

butable to the superiority of the Prussian rifles. Firing rapidly, about three times as fast as the Danes, who were armed with the ordinary four-grooved, muzzle-loading *Minié*, they availed themselves of the intervals between the successive salvos of the enemy, to pour shot upon shot into him whilst loading. To this the Prussians were indebted for their success at Büffel Köppel, which secured the evacuation of that village and the outlying ground—the Danes retiring rapidly, leaving many men in the hands of the enemy, and carrying off a number of wounded.

A similar result ensued at the final capture of the Düppel forts; and the following episode has been quoted in proof of the effective fire of the needle-gun on the latter occasion:—A company of the Prussian Guards, following up the Danes after their retreat from one of the forts, drove a battalion out of a farm-house and the buildings which it occupied. On perceiving, however, the numerical inferiority of the force that had ejected them, and not seeing it supported, the Danes returned to the charge, and thought of retaking what they had lost, but the Guards opened upon them so formidable and continuous a fire with their needle-rifles, that they were glad and compelled again to beat a retreat.

Now one authenticated fact, such as this, is worth a host of conjectural speculations as to what breech-loaders might effect, and tends strongly to confirm the opinion, that steady soldiers, armed with breech-loaders, are a match for two or three times their own numbers. Had the Danes been provided with this weapon, how different might have been the result of the struggle, wherein this small but gallant nation has had to contend behind entrenchments against overwhelming numbers. Indeed, to nations with small, or comparatively small armies—like England—the breech-loader is imperatively necessary, since, by the very proposition of her paucity of numbers, each man should be equal to ten of the enemy on almost all occasions of conflict. Indeed the argument cuts economically as well, since if the present strength of our army be sufficient, when armed with breech-loaders it might be reduced in accordance with the increased efficiency secured by the weapon.

For our part, now that a breech-loader has been adopted as the universal arm of one great continental army, and as it is known that both the French and Belgian Governments are on the eve of taking a similar step,* we believe that no alternative is left us but to adopt the system without delay. It has just demonstrated its superiority. What more can we need? Can any "Report" whatever rebut the facts of the late campaign in the gory fields of unfortunate Denmark—unfurnished with a weapon which might have given her invaders a lesson to be remembered—instead of seeing her brave little army crushed before overwhelming numbers. Can we for an instant contemplate the possibility of our not taking the most speedy and ample measures to secure to England perfect immunity from such ruin and calamity?

* Since this article has been written the author has been given to understand that a breech-loader, on the needle principle, but much simplified, is being introduced almost universally into the ranks of the Federal army of North America.—A. W.

To hesitate in this matter is to be lost.

But even apart from these considerations, so vital to the existence of the nation, the adoption of the breech-loader is necessary on account of our almost constant state of warfare in some part or other of the globe. As Lord Elcho pertinently put it to the House of Commons on a recent occasion, what would be the position of an English contingent, if it should find itself opposed to a force armed with breech-loaders?* The alternative of making rapid charges, so as to resort to the bayonet, would doubtless be the practical solution necessitated; but, unfortunately, it is precisely in meeting or repelling such charges that the superiority of breech-loaders would become most evident; for, men so armed, and with bayonets fixed, can keep up a continuous fire *till the very last instant*—since, in a measure, it is never necessary to move the rifle from the position in which it must be held, when resisting the advance, either of infantry or cavalry. General Rémond, of the French army, avers that infantry armed with breech-loaders, and readily "forming fours," will dispense with the usual formation of squares—which checks the advance of troops, and renders them so vulnerable to artillery. With breech-loaders, effectual fire of the deadliest kind could be delivered with a rapidity that nothing could withstand, namely, in four ranks, and even in five,—the first lying, the

second sitting, the third kneeling, the fourth and fifth standing. See accompanying diagram.†

In the presence of these facts, we may hesitate as to which *principle* of *breech-loader* we should adopt, but not for an instant as to the adoption of *the weapon*.

Undoubtedly the most cogent argument against the introduction of breech-loaders into the army, is the alleged likelihood of soldiers squandering away their ammunition; but this argument is very much like that which was advanced as fatal to the introduction even of the *Enfield*. Military men said it was too delicate a weapon to be placed

* In the debate referred to, Lord Elcho pointed out that although a Committee, appointed by the House itself more than two years back, had reported that a much better weapon than the Enfield could be manufactured at exactly the same cost, yet the manufacture of the inferior weapon had been continued at the rate of 1,000 per week, and the House declined, by a considerable majority, to endorse the conclusion of its own Committee or make any change.—A. W.

† This diagram is taken from "The Rifle, its Theory and its Practice," by the author.—A. W.

in the hands of the British soldier! Experience has utterly refuted the imputation. Of course, it must be admitted that a badly disciplined regiment, with careless officers and negligent sergeants, at the beginning of an action or campaign, would probably fire away its ammunition too quickly, but it may still be, that its effect, even in such hurried circumstances, would surpass that of ordinary rifles. Moreover, we have no right to assume that men trained to use the breech-loader, and constantly cautioned not to throw away their shots, would necessarily and perversely do so—with every consideration, both national and personal, to make them anxious to husband every shot at their disposal.

But what does the able correspondent of the "Times," who accompanied the Prussian army throughout the recent campaign, declare on this very head? He says, "I repeatedly asked the Prussian officers whether they found that the facility of loading had the bad effect of making the men fire too rapidly, and waste their cartridges; but they tell me it has not." And are we to be told that British soldiers will necessarily be less provident of their ammunition than the Prussian?

But surely, even supposing this objection were well grounded, and even insuperable, it would be better—rather than lose the manifold advantages resulting from the use of breech-loaders—to devise a method of impeding the soldier's access to his ammunition by some mechanical arrangement of the cartridge box. We cannot think such a precaution necessary for the taught soldiers of the British army; and most assuredly the appliance would be absurd, as actually defeating the very object we have in view—the utmost rapidity of fire combined with effect; and in venturing the suggestion our only object is to plead, by all means, for the adoption of this greatest military boon ever vouchsafed to the soldier. If the obstructive prejudice against breech-loaders in this respect prevents its adoption, we can take means exactly to regulate the number of shots he can fire per minute.

It was said, after the introduction of iron-plated ships, that any Minister who should send our sailors forth to battle in wooden ships, to their inevitable destruction, ought to be impeached; but what should be said of him who would allow our soldiers in any future war to be shot down whilst standing up to load his gun, during the tedious rodding and capping motions, when he might be armed with a weapon which would effectually prevent his exposing his body, and unnecessarily sacrificing his life?

At the great Hornsey-wood pigeon match the other day (2nd June), it was remarked that two-thirds of the guns used were breech-loaders, and that more than half the prizes were carried off by them, so that it would appear that the prejudices that existed when they were first introduced have gradually died away. Yet it appears a curious perversity of judgment that a breech-loader should be preferred for pigeon-shooting, deer-stalking, and cover-shooting, on account of its greater convenience and destructiveness, and yet refuse to the soldier the same advantages for dealing with his larger and more dangerous game.

There is another disadvantage connected with a muzzle-loader, which is not likely to present itself except to a man actually in the

service,—we refer to the time and labour required to be expended on the recruit to make him thoroughly conversant with and habituated to that dreadful platoon-exercise, which is one of our military perfections so completely in accordance with the slow-coach of battle in the 17th century. It requires a long time to acquire the habit of loading properly, so that in the hurry and excitement of the battle-field, it shall be as a second nature. Facts amply support this averment. It is related that, after the battle of Gettysburg, the muskets found on the ground not discharged were loaded, or rather mis-loaded, in the most extraordinary variety of ways. In some were bullets without powder, and in others powder without bullets. Others had cartridge after cartridge on the top of one another, whilst at the base of the nipple-hole a piece of paper appeared to have been carefully jammed so as effectually to prevent the ignition of the charge. Some, again, were loaded and capped ready for discharge, with the ram-rod left in the barrel.

But, indeed, we need not cross the Atlantic for illustrations of this malpractice; for, unfortunately, at the last Volunteer Review at Guildford, the death of a clergyman by a ram-rod driven through him, sufficiently testifies to the difficulty of getting indifferently drilled men to go through all their loading-motions correctly.

The action of skirmishers in future battles will be most important; and their special action consists in their well-aimed shots. But all know the difficulties of skirmishers in properly loading on the present system.

It is impossible to get all the powder down to its proper place; after a single discharge some of it must stick to the sides of the bore, even if the barrel be kept perfectly perpendicular—which is impossible in skirmishing. Besides, some must load kneeling or lying. Now it is certain that every grain of powder in the charge is absolutely necessary—the weight being the minimum.

There is absolute immunity from all these disadvantages in the breech-loader, wherein (with the Westley Richards for example) the loading simply consists in raising a lever, pushing in a cartridge tip foremost, and shutting down the lever. The rawest recruit could be taught his "platoon exercise" in the course of a single day, and the veriest tyro could hardly make a mistake.

We might dilate at greater length on the other numerous advantages, in the tactical point of view, which the adoption of breech-loaders would secure to the soldier; but most of these are really too self-evident to need any advocacy, and we shall therefore proceed to consider, in detail, the weapon experimentally issued by the Right Honourable the Secretary of State for War, to whom it is difficult to give too much credit for even giving the principle a trial.

The two thousand breech-loaders referred to at the beginning of this article, are made by Mr. Westley Richards of Birmingham, and the principle of construction is the one identified with his name, and as the weapon is likely in some shape or other to become a service arm, we proceed to give it a brief description.

Fig. 8 (Plate XXXI) represents a section of the breech-loading parts.

A is a gun-metal plunger which enters the breech end of the gun; B is a solid iron block with an inclined plane at the back, C. There is a second inclined plane at the point E, which throws the block B back into its place, and makes it fit close against the end of the box, F, which is also undercut, to fit the inclined part of the block, B, at the point C. The block has a sliding motion to allow this action to take place. By this it will be seen that the greater the pressure on the block and plunger the safer the part becomes, the inclined plane holding the lever firmly down in its place. D represents the cartridge. Fig. 9 exhibits the rifle ready to receive the charge, and shows how the breech is raised to load the gun, the junction being behind the cartridge. When the rifle is closed, a small lump, marked A in Fig. 10, is the only projecting part; in all other respects the gun has the appearance of the ordinary rifle. The barrel is that of the Whitworth in every respect, save the number of sides in the bore, which are eight instead of six—hence the bore is octagonal (Fig. 7, Plate XXX). With the rifle proposed by Mr. Richards as a service arm, the bullet to be used will weigh 500 grains, certainly not more, and probably less,—the charge of powder to be 80 grains or 2·92 drs. The weight of the gun with bayonet is about 10 lbs., the barrel 3 feet in length, and much stouter than that of any musket made for our service. With this gun the following results were obtained at a target on a favourable day:—

20 shots	at	600 yards,	elevation	1° 21′,	gave a figure of merit of	6·96	ins.
20	„	800	„	1°50″	„ „	11·85	„
20	„	1000	„	2°50″	„ „	17·50	„

Average shooting, taking all kinds of weather,

600 yards	9·50 to 10 inches.
800 yards	13·50 to 14 „
1000 yards	22·00 to 24 „

These figures speak volumes in favour of its precision of fire and lowness of trajectory; and for safety and simplicity of loading, we believe this weapon to be at present unsurpassed as a breech-loader; but, unfortunately, it is deficient in one essential speciality of a breech-loader,—it retains the detached cap system of the ordinary rifle, introduced at the beginning of the present century as a mode of ignition; consequently, its rapidity and facility of loading are sadly impaired and diminished.

We have reason to believe that Mr. Westley Richards himself suggested to the authorities the propriety of combining with his breech-loader some well-considered method for igniting the charge without the intervention of the now antiquated percussion-cap, by means of a direct detonation applied to the base of the cartridge, somewhat on the principle of the Prussian needle-gun; but he was at once told that the idea could not be for a moment entertained, because any such method was incompatible with the requirements of a military fire-arm! So, to fall in with some fixed and determined rule, the miserable little cap

is to be still supplied to the benumbed, agitated, or fumbling fingers of the fighting soldier on the field of death. The reply bears a striking and rather unlucky resemblance to that accorded to poor Captain Norton in 1824, when he first brought forward a self-expanding, elongated projectile, on the very system now universally adopted, viz., that a "spherical ball was the only shape of projectile adapted for military purposes."

Now, let us examine the question, and see what is really sacrificed by retaining the copper-cap system. It involves the necessity of carrying two distinct kinds of ammunition, and therefore increases the risk of its getting out of order two-fold; in other words, although a soldier's cartridges may be in a perfect state of preservation, should anything happen to impair his caps—which, by the way, must be carried in a separate pouch—it would at once render the soldier's rifle ineffective. Some of the caps may be dropped in capping or otherwise, and he may have cartridges without the means of firing. Everyone knows that there is oftentimes much annoyance and confusion arising from want of caps in time of action, and that either from carelessness or accident they run short long before cartridges.

Moreover, irrespective of the cap itself, the Musketry Book of Instruction, p. 18, assigns no less than seven other causes for the non-ignition and non-explosion of the ordinary charge in use, any one of which may occasion a miss-fire. Unquestionably the present mode of charging is utterly incompatible with the requirements of modern tactics, suggested and necessitated by the introduction of the improved rifle.

The practical result of this old system was well exemplified very recently, at the battle of Oversee in Denmark, on which occasion the Austrian rifles, owing to their having undergone some exposure to the weather, would not go off, and a part of the troops engaged had, in consequence, to charge with their bayonets over a long distance under a heavy fire from the Danes, with severe loss in killed and wounded.

In striking contrast with this state of things is the account given of their needle-gun to one present with the Prussians:—"The more they use it the more pleased they seem to be with it. This very morning I have been speaking about it with the adjutant of a fusilier regiment quartered here. He assures me it proves most solid and serviceable, never gets out of order or misses fire, not even when, as in the early part of the campaign, the men were lying out in the snow, and their arms got wet and covered with rust."

Now, unfortunately, owing to the peculiarity of the Westley Richards' cartridge, and the fact that it requires a very strong flame to penetrate the paper powder-case and the fatty lubricant surrounding it, a special description of percussion cap is necessitated; and hence, for a time at least, we must have to endure the evil of two kinds of percussion caps in the service. But even with this special cap, and under circumstances the most favourable, it is notorious that with the Westley Richards' breech-loading carbine, which has been served out to the cavalry for some time past, miss-fires are of very frequent occurrence, averaging

something like 20 per cent.* From whatever cause this serious result may proceed, the fact remains, and it can on no account be overlooked; but in drawing attention to it, we are anxious to point out that it is in no way attributable to the breech-loading system, as a system, which cannot be made responsible for the defect mentioned. The persistence in the use of the old cap is the cause; and had the authorities ever experienced the horrible revulsion of the feelings produced by a miss-fire in a moment of peril, they would doubtless recognise one of the "first requirements of a military arm" to be, the certainty of its fire on all occasions. Latterly attention has been drawn to the number of accidents, in the shape of flesh wounds in the face and injuries to the eyes, inflicted by splinters thrown off by inferior copper caps; the recurrence of such disagreeable contretemps tend materially to impair the soldier's confidence in his weapon, and the precision of his aim.

Perhaps, however, the most conspicuous objection to the employment of a separate percussion cap, is that it requires six separate actions of the hand to knock off the old cap, take up another, place it on the nipple, and press it properly home. An ungloved hand, in warm weather, can, of course, perform all these motions, with comparative ease and rapidity, on target-practice grounds; but having to do the same thing with a fur-glove, in a Canadian winter, during the excitement of active service, is a very different affair, and would constitute a disadvantage, even in breech-loaders, such as would seriously affect the issue of a battle, so far as that issue depended upon infantry.

At best, therefore, we can only regard this description of breech-loader as a sort of compromise or half-measure. Of course the consideration which really influenced the authorities in retaining the percussion-system, might be the safety of the soldier himself; but surely at the present day, with the Prussian needle-gun, and self-igniting cartridge, as a pattern to improve upon, and with our boasted mechanical skill and knowledge of chemistry, something could be substituted as a mode of ignition for that which is nearly as great an inconvenience and disadvantage as the use of the ramrod itself.

If any difficulty is experienced by the authorities in obtaining such a substitute, let the matter be thrown open to competition, and in this 19th century we feel well assured that entire success will be the result.†

* In justice, however, to Mr. Westley Richards, we should state that these miss-fires occurred with caps supplied by the Government Laboratory, and that with caps prepared especially by Mr. W. Richards, miss-fires were reduced to something like one per cent. Since the above was written, Mr. W. Richards has arranged to do away with all the lubrication on the powder part of his cartridges (which amongst other advantages makes them much cleaner to handle), and the Government are about to issue an improved service cap, which will make more than one description unnecessary.—A. W.

† Since the above was written, a Mr. Burton, from America, has exhibited at the Institution a breech-loading rifle, with metallic cartridges, carrying their own ignition, which appears to meet all the requirements of a breech-loading small arm as here indicated.—A. W.

Experience is said to teach; let it teach us before it is too late. We have seen how a brave people has had to succumb to enemies vastly their superiors, not merely in numbers, but in their armaments. Let us take the lesson to heart. Our army, numerically at least, is vastly inferior to those of the great continental powers; then let us make amends for any deficiency by the perfection and efficiency of our equipment and organisation in its minutest detail: and that which we have been considering is certainly one of the most vital importance to us, since it is equivalent to the question whether we shall triple, at least, our effective strength by the adoption of a good breech-loader.

As the Duke of Wellington often said, "Looking at the amount of mechanical skill in the country, and the numerical weakness of our army, as compared with those of the great Continental powers, British troops ought to be the best armed soldiers in Europe;" but until each soldier carries a well-devised and well-constructed breech-loader, with a rifled barrel, either on the *Lancaster* or the *Whitworth* principle, we must remain under the depressing reflection that our present armament is, in this respect at least, inferior to that of more than one Continental power.

The CHAIRMAN: Our gallant friend, General Boileau, need not to have repudiated any responsibility in respect to that paper. It is a very able one; we shall be very glad to hear any questions from gentlemen present, and I have no doubt the General will be able to answer them. Perhaps the gallant General will favour us with some observations of his own.

General BOILEAU: I should like to say a few words upon the subject of breech-loaders. The writer of this paper spoke of the form suitable for the grooving of breech-loaders as being either the Lancaster or the Whitworth principle. I think there is a great difference in the principle of those two forms of rifled bore. The Whitworth bore, being a polygonal bore, has angles which trench upon the metal of the barrel. I believe in a rifle which he has recently constructed, and which has performed such great feats at Woolwich, the barrel could not be made more than three feet long, to bring it within the limit of weight of 10 lbs., that being considered the maximum that a soldier ought to carry; and it certainly is the maximum. On this ground I think the Whitworth principle is not suited for a breech-loader, as an arm of precision especially. The Government at present appear to retain the idea, that for a military arm, the calibre should be comparatively large, and the late Duke of Wellington had the greatest objection to permit the bore of the old Brown Bess to be reduced at all; it was reduced, however, from something like 0·750 of an inch to its present calibre, which is 0·577 of an inch. An arm of precision requires that the bullet should have a certain ratio of length to the diameter, now generally assumed to be two and a half to one. In rifles of large calibre, the necessity of increasing the length of the bullet, even where the base cavity is very large, adds greatly to the weight. The bullet which Mr. Whitworth used at these wonderful experiments at Woolwich, where the figure of merit of his 0·577 bore rifle surpasses probably that of his small bore, had a weight of 600 grains. I have a rifle made for competition at Wimbledon with a very rapid pitch in the twist, retaining, as I was obliged to do, the Government bore; and I find that by the greatest possible care that can be taken to get a bullet which will give precision at long ranges, it is impossible to do so with the 0·577 bore, and to keep the weight of the bullet under 600 grains. Now, if the soldier has to carry sixty rounds of this or similar ammunition, you add 1 lb. to the weight of the bullets alone which he has to carry, and you add at least 1 lb. to the weight of the rifle. That is you cannot make a rifle with a 0·577 bore to carry a long bullet which shall not weigh 600 grains, and to shoot with precision up to 1,000 yards; and you cannot make a rifle sufficiently strong to resist the increased charge of powder, and the increased twist, under 10 lb. So that, I think, if a new form of

WESTLEY RICHA

Fig. 8.

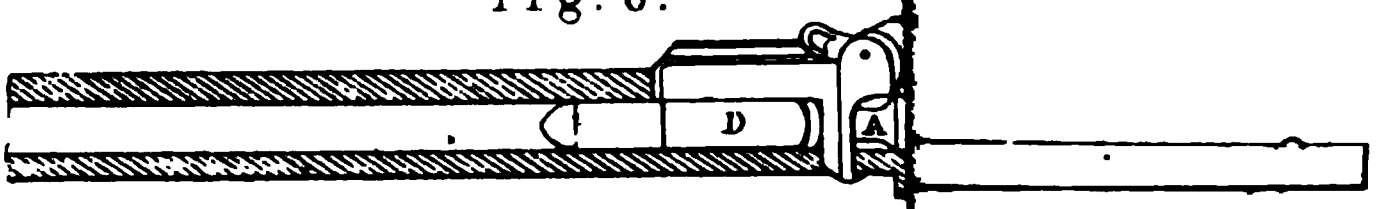


Fig. 9.

g. 12.

Ready to receive charge

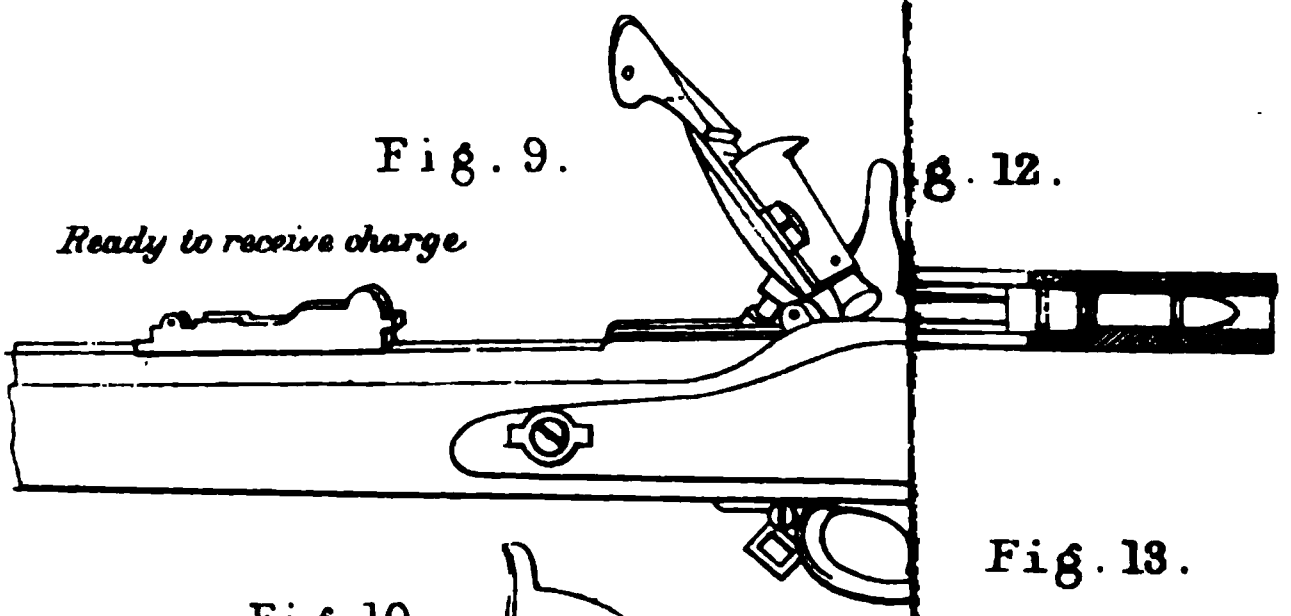
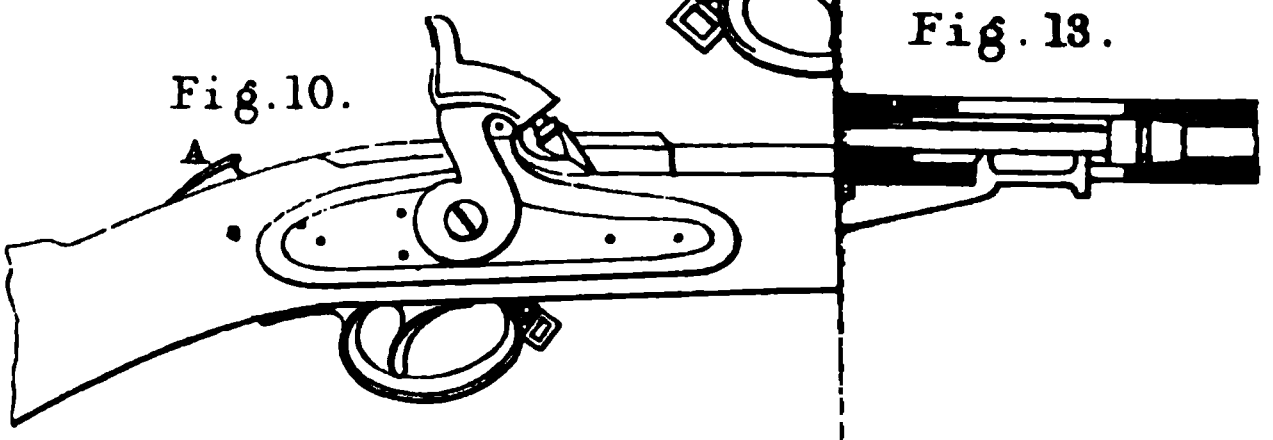


Fig. 13.

Fig. 10.



MONT STORM

Fig. 21.

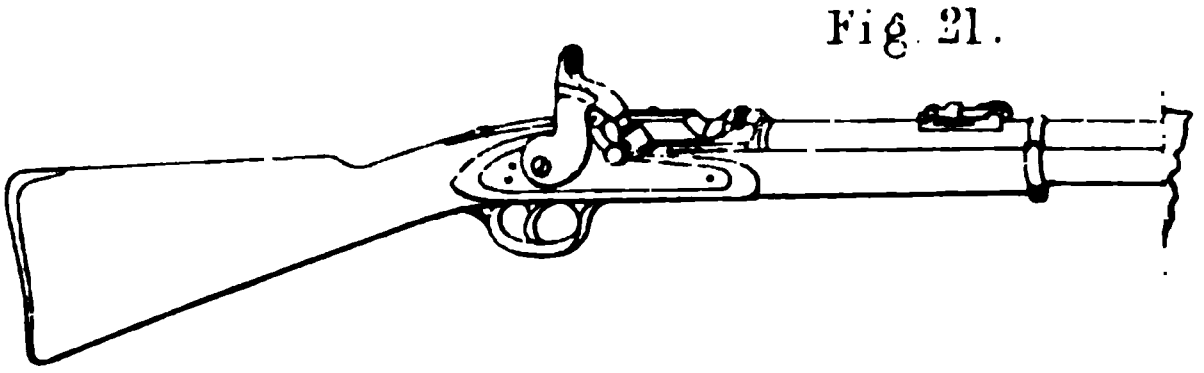
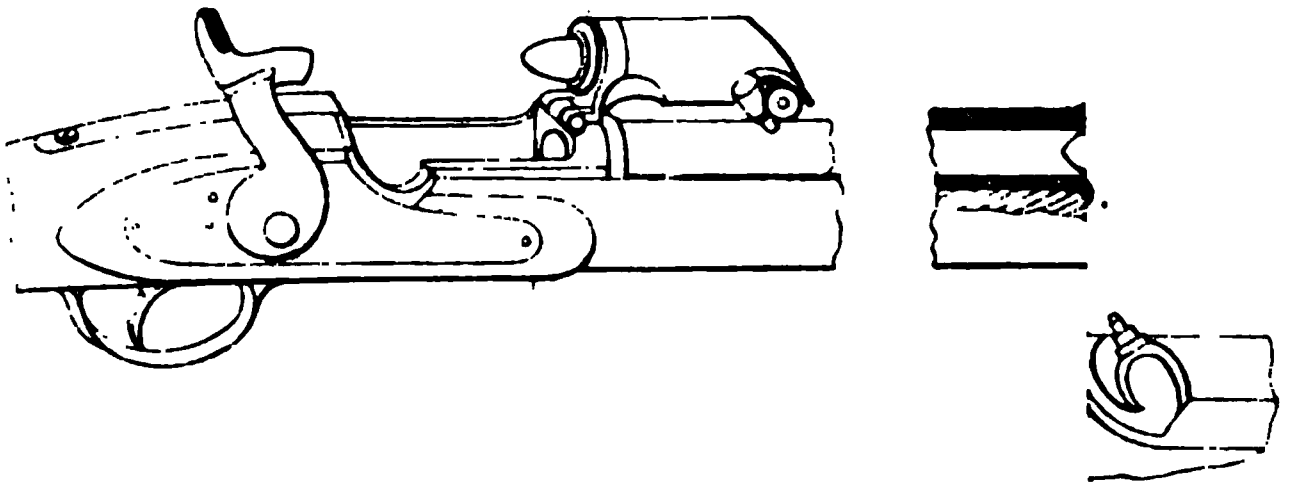


Fig. 22.



J.R. Jobbins.

arm is designed, especially a breech-loader, it will be necessary to reduce the diameter of the bullet to such an amount as will admit of an elongated projectile which shall have the length to the diameter in the ratio of two and a half to one, or thereabouts, and which shall not weigh over 500 to 530 grains. This may be done with a barrel having a bore of half-an-inch. I have several rifles made of this calibre, which I hope to produce at Wimbledon. I find that a bullet with a diameter of ·488 inches, weighing 500 grains, gives a length of two and a-half times the diameter, and it secures precision of shooting up to 1,000 yards. A rifle carrying a bullet of that weight and of that diameter, may be made to weigh under 9 lbs. I have one which weighs about an ounce and a half under 9 lbs., and another which weighs rather less than 9½ lbs. By reducing the calibre, you secure lightness, and you secure length, with less weight of bullet; so that a man may carry 60 rounds in his pouch, and yet not be loaded to the same extent that he is now, for the Government bullet weighs 530 grains. Then there is another advantage in keeping to the smaller diameter. We shall not, however, come to such a small diameter as shall prevent the rolling of a comfortable and well-constructed cartridge. Now, the diameter of the small-bore Whitworth rifle is too small for this purpose. You cannot make a cartridge which will be sufficiently stiff to retain its form, and to admit of the bullet being loaded as at present. But with a half-inch rifle you can do so. I have made many cartridges, and have fired them out of my rifles with the same facility as I can with the Government rifles. That enables you to retain length of barrel. I do think there is no alteration in the form of a rifle which is more prejudicial in its usefulness in the hands of an infantry soldier, than taking anything, even half an inch, from length of the barrel. I believe in war we shall still have on occasions to decide the issues of a contest by close-quarter action, that is, with the bayonet; and there is no question that the man who gets the first prod, if it is only half-an-inch, has the advantage. Therefore, if you shorten your barrel by three inches, as in the Whitworth large-bore rifle, you put your soldier in a false position; his bayonet will be of no use against the longer bayonet and longer rifle of foreign nations. I hope to exhibit here a half-inch bore-rifle with a 3 feet 3 inch barrel and with a bayonet 3 inches longer than that now in use, and which shall not weigh more than the present Government rifle. Here are some rifles which I shall be happy to explain.* This is a Westley Richards' (Plate XXXI, Figs. 8, 9, 10); Lieutenant Walker thinks it the best design; I am not of that opinion, I think it has one disadvantage. It has a hinge and the breech-piece is fixed. In a breech-loading rifle, if it can be made for all its movements to be rectilinear, that is in a direction perpendicular to the faces which have to be brought together to close the breech, you are more likely to secure contact than you can by any application of curvilinear movements. A rifle has been invented by a non-professional gentleman, and to my apprehension it is the best that has been brought out. It is the design of Mr. Green (Figs. 15—20): its principal is that which I have always approved, that of rectilinear motion. You pull the breech-piece straight out, and push it straight in. The cartridge is dropped in as in Westley Richards'; the breech-piece is closed, the lever is turned down, and then the plug, by the action of two sloping studs bearing against two surfaces in the piston, pushes the breech-piece tight home, and the gun is fired in the usual way. There is a feature in this breech-loader rifle which I do not think exists in any other, it is, that the breech-piece can be taken off and entirely removed from the rifle. You can pull the breech-piece out and put it into your pocket, and make your rifle a present to your enemy, and it will be of no use to him. I have seen no other rifle which possesses this great advantage; indeed, in this respect it has a superlative advantage over all others: the breech-piece can be inserted, and can be pulled out with equal rapidity. The rifle cannot be fired unless the finger-piece is turned down to its proper place. The reason is this: when the lever is turned down, there is a small hole in the bottom part of the plug which goes over a pin. The pin is worked by the trigger, and fits into the hole of the plug. When the lever is not turned down,

* Terry's breech-loader having been referred to at a previous meeting, it has been thought desirable to insert it, for the sake of comparison, &c., in the plate of breech-loaders referred to in this discussion, it is given in Figs. 11—14.—Ed.

the lever is turned on one side, and the pin which is in connection with the trigger is brought against the solid part of the plug, and the piece will not go off: but as soon as the lever is brought down, the piece goes off. That is Green's breech-loader. I shot with it myself last week at Kilburn; I fired eight rounds from it at 400 yards: and out of eight shots, I made six bulls'-eyes and two centres.

Captain BURSLEM: I believe the idea of the Government, with respect to the metallic ammunition for a breech-loading rifle, is that the copper cases carrying their own fulminate are liable to explode. I have had a breech-loading rifle since 1860; it has been half over the world with me, and I have never found the ammunition explode. I think if the Government were to try it in any way they like, they would find that those cartridges are not more liable to explosions than others.

The CHAIRMAN: I am at a loss to conceive what real objection there can be to breech-loading. It is strange that those who recommended the adoption of breech-loading to cannon almost to the exclusion of every other description of gun, should have hesitated about adopting it to musketry. There are just ten reasons to one in favour of a breech-loading musket over a breech-loading cannon. The breech-loading cannon is only of value on certain occasions, where it is fired on the non-recoil principle. Now, the argument that is adduced, or professedly brought forward, against the breech-loader is, that it will lead to a waste of ammunition. Rightly viewed, I believe it is the very reverse of the fact. It is the nervous excitability increased by the fear that you are not loading fast enough when you are ramming home and putting the cap on, which all people feel when they enter into action for the first time, and the excitement arising from success or partial failure, which in my opinion leads to the useless waste of ammunition. But if a man is sure of his gun, if he is sure of everything concerning it, he can put in his charge just at the right time, and have it ready for action at the very moment he wants it; he will be comparatively calm, and can use his gun to advantage; his mind will not be upset by the excitement of haste and uncertainty. I quite concur with the General's remarks about the Whitworth and Lancaster rifling. I do not see how, with Westley Richards' form of breech-loader, you are to use it effectually with that description of rifling. With the peculiar motion of turning down that he has, with the polygonal form of rifle in one case, and the oval form in the other, you would not have a perfect junction, and there would be an escape of gas: whereas in the other description, where it goes home, there you might have a perfect fit. I do not see how the two can be combined.

General BOILEAU: There is one point I omitted to explain, which is the peculiarity of this plug of Mr. Green's. The fore-part of the plug is finished by a solid disc. The plug is bored, and there is an axis which fits into it, which is finished also with another solid disc. Intermediate between these two Mr. Green places a wad of mixed gutta-percha and vulcanised india-rubber. He found that the rubber itself was too soft, and the gutta-percha probably too brittle. With a mixture of the two he has succeeded in obtaining just sufficient elasticity and resisting power to secure the desired object. When the cartridge is ignited, the powder acting, of course, in both directions, before it has had time to start the bullet has compressed this disc slightly, has squeezed out, so to speak, a portion of the wad all round it, by rendering it thinner; and by that means has most perfectly and effectively rendered the breech gas-tight. I fired fifty-five rounds with another of Mr. Green's rifles at Kilburn, twenty-five from the muzzle and thirty from the breech, to try whether it would act as well as a muzzle as a breech-loader; and after the fifty-fifth round, when we drew the plug out, the breech chamber was as clean and bright, and as free from the fouling which smoke produces, as if it had never been fired at all. That is an unanswerable proof that the apparatus is perfectly gas-tight. Then, it has another advantage, and that is its perfect applicability to the whole of the Government rifles now in store, the long Enfield, the short Enfield, navy, and carbine. In fact, Mr. Green has fitted his breech-loading apparatus to six different forms of rifles for the Government. They are now under trial at Woolwich. The result with the long Enfield is decidedly good. The only point in which he has not succeeded is the construction of the cartridge. The 0·550 small-bore windage bullet does not suit the breech-loader; it does not suit the Lancaster; but the larger-sized bullet, the 0·570 bullet, answers admirably. With the navy five-grooved rifle I had not that

difficulty with the 0·550 bullet, but still the 0·570 bullet gave much better results. There is another rifle which I may bring to your notice, which is commonly called the Mont Storm rifle (Figs. 21—23). The mechanism of this is exceedingly good, and it has its advocates. I do not myself approve of it. I think where you commence your operation by counter-marching, as it were, the breech, where you insert your cartridge tail foremost, your soldier in the heat of action will be apt to make a mistake. Without reasoning upon the mode in which the bullet should go, I think the first impulse of the soldier is to put in the cartridge, bullet foremost. Without wishing to speak therefore but in praise of the beautiful work and mechanism of this rifle, I think that is a wrong point in its design—that the soldier is to be taught to put the bullet in the wrong way, in order to make it go out the right way. There is another objection to this, as in the case of the Westley Richards' rifle, although there the action of the slide to a certain extent does away with the objection. To bring two bearing surfaces into perfect contact, where they move upon a hinge axis, and where the motion is circular, there must be a wear; and where there is a wear there must be an escape of gas. On that account I think the hinge principle is bad for breech-loaders. Therefore, I prefer the plug principle of Mr. Green, which is simple, cheap, and effective, and which must command attention. I have no doubt that before many months are over we shall see something done. But there is another point connected with breech-loaders which I think is very likely to exercise an important influence, both upon the design and upon the weight of the piece, and that is the introduction of gun-cotton. A portion of the weight of the rifle, as it is now manufactured, has become necessary, from the great recoil which gunpowder produces; there is a necessity, therefore, for making the piece of a certain weight to resist that recoil. But with gun-cotton there is comparatively very little recoil, not a fourth part in some cases of the recoil produced by gunpowder. Therefore, I believe it will be possible to reduce the weight of the piece very considerably without in any way destroying its efficiency, should gun-cotton be introduced as the explosive agent for small arms. General Sabine, with whom I have had a conversation on the subject, is of opinion that breech-loaders will ultimately force their way into notice, and become the weapon of the soldier, as well as the form of artillery; that they are so peculiarly suited to gun-cotton, where there is no smoke and no recoil, that they must command attention, and will ultimately force themselves on the notice of our not very fast, though, I believe, very sure Government.

The CHAIRMAN: You will allow me to record our thanks to the officer who sent us the first paper. Although not so important as the second, it is a very important and interesting paper. The comfort of the soldier is a very important thing, because in the field it is a large element in his efficiency. We also return our thanks to the gentleman who sent the second very interesting and very valuable paper. It is a remarkable paper for a young man to produce. He seems to have a genius for his profession, and to take a practical view of the subject. And it is a practical view that we want, for in the present day transcendentalism has taken the place of practice. And though last, not least, I am sure you will return your thanks to our friend General Boileau for the very luminous instruction and explanation he has given with respect to breech-loaders. I may make a remark with reference to his closing observation as to the curious anomaly it appears to be that gun-cotton has no recoil. I heard an explanation offered for it: it was simply this, that there was no residuum from gun-cotton; while there is about 75 per cent. from gunpowder, which is left as practically as another bullet which is projected backwards; while the lead bullet is projected forwards, this 75 per cent of residuum is projected backwards, and is the cause of that recoil. I give it to you as I got it.

General BOILEAU: I am very much obliged to you for the kind way in which you have received the paper this evening, and for the favourable remarks which you have made upon the efforts that I have made to give it the weight which I think it justly merits.

---

*ADDENDUM TO "BREECH-LOADERS FOR THE ARMY:" BEING REMARKS ON THE RESULT OF THE AGITATION OF THE BREECH-LOADER QUESTION, AND CONCERNING THE INTRODUCTION OF GUN-COTTON INTO MODERN WARFARE.

By Arthur Walker, Esq., Lieutenant 79th Highlanders; Lieutenant Instructor School of Musketry, Fleetwood.

In these days of railways and electricity, which seem to lend to modern men a reflex of their promptitude, celerity, and decision in all their doings, events succeed each other so thick and fast, that even the steam printing machine can hardly keep pace with their rapid march. The foregoing paper, and the remarks it elicited at the Royal United Service Institution, had scarcely been consigned to the press and given to the public, when the arguments therein contained received a flattering endorsement from the military authorities, the theoretical conviction on their part having been followed by a prompt determination to give it effect in practice.

In fact, so much had transpired in a variety of ways on the subject of breech-loaders, during the last year or two, that the feelings of the country were becoming fairly roused, and the public mind was fast approaching the point of demanding that the army should have the benefit of the undoubted superiority of breech-loaders over muzzle-loaders, when, with prescient sagacity and meritorious promptitude, Lord de Grey and Ripon forestalled any such pressure from without by taking action in the matter himself.

He decided to submit the question in its integrity to the thorough investigation of a competent military tribunal, composed of seven officers,† whose high standing and varied experience on the subject afforded an excellent guarantee for the soundness of their judgment and the propriety of their decision.

This committee assembled on four occasions, and after examining a number of witnesses, it arrived at the unanimous conclusion that it was advisable to arm the whole of our infantry with breech-loading rifles.

Beyond this emphatic recommendation nothing was done in the

* Contributed in September, 1864.—Ed.

† The following are the officers of the Committee referred to:—Major-General David Russell, C.B., President; Colonel Thomas Steele, C.B., late of the Coldstream Guards; Colonel The Earl of Longford, K.C.B.; Colonel Clarke Kennedy, C.B., Commandant of the Military Train; Colonel Parke, C.B., Commandant at the Fleetwood School of Musketry; Colonel Adye, C.B., Royal Artillery; and Colonel Walker, C.B., formerly of the 2nd Dragoon Guards, and now Assistant Quarter-Master-General of the South-Eastern District.

way of detail, except that attention was directed—in the event of the decision of the committee being adopted—to the necessity of a more efficient service for the transport of the first reserve of ammunition; and of such importance was this considered by the authorities, that another special committee has since been appointed, with the view of examining the suggestion made on this head by the former.

The first reserve of ammunition should, obviously, be made to accompany soldiers whithersoever they may have to go—whether along the path of a mountain-defile, or in making a flanking detour across a river by a bridge of planks or boats. To convey this supply, pack-mules or horses (but the former are much to be preferred) should be substituted for the present system of cartage on service; or perhaps some description of handcart, or tumbril, on wheels, could be devised, so light and portable as to permit of its being easily moved along by one or more men, and capable, on occasions, even of being transported on their shoulders. A certain number of extra men would have to be told off for these tumbrils and to supply the pouches from them. At present each brigade carries its own ammunition, but with a breech-loader, that can be fired five or six times as often as a muzzle-loader, it will be absolutely necessary that every *company* in a *regiment* should have its proper quota of ammunition transport attached to it, just as it now has its quota of pioneers and buglers, the reserve ammunition for the *brigade* and the *division* being kept quite distinct.

Some such provision is absolutely necessary; but we are inclined to think that even more attention and consideration in this matter should be given to the soldier himself, with respect to the load of ammunition which he has to carry. It is generally becoming evident that the day has gone by for heavy-weighted soldiers; and the prevailing opinion is that a kit of over 50lbs. weight is rather too much for our modern soldier, or rather rifleman-sharpshooter, whose salient characteristic must be the utmost agility, promoted in every way by convenient equipment, in order to meet the sudden requirements which will be necessitated in future warfare, wherein if anything be certain, it is that victory will depend upon the accurate *coup d'œil* of the leader in deciding upon action, and the promptitude with which his soldiers can carry out his object.

Heavy, massive, unwieldy regiments are as obsolete as Frederick William's Patagonian Grenadiers: the days of old when battalions leisurely advanced, till they could distinguish the whites of their enemy's eyes before opening fire, are now long past; the deadly missile begins to pour in at a distance at which even the sound of its discharge is inaudible, and the foe himself appears little more than a thin dark line upon the landscape. To advance now "very slowly," (*fort lentement*), as Todleben, *the* hero of the Crimea, describes our troops to have done at the Alma, towards an enemy's breast-works, in the face of rifled guns and troops provided with breech-loaders, would only be equivalent to advancing "into the jaws of death."

We must apply the Banting-system, as it were, to our heavy-booted, over-fed, and over-clad Grenadiers, for depend upon it, it is your light-footed, clear-eyed youth, breech-loader in hand, with open collar and

no 50lb. knapsack to drag him to the earth—like a race-horse over handicapped—who will turn the tide of future battles.

Let us imitate the "loose order" and rapid concentration of the battle of Solferino, rather than perpetuate that tardiness of movement which cost us so much in the Crimea, both in men and reputation.

Obviously, therefore, the strength of the soldier must no longer be wasted in doing the work of a travelling packman, or rather a pack-horse, but, on the contrary, husbanded for the work for which he is specially intended. With this view, the weight of his kit should be reduced, and his dress modified, so as to permit him to carry some thirty or forty rounds more of ammunition.* After victory plenty of kit haberdashery can be got for the mere seeking; but ammunition is to be procured only from one shop, and that may be very far away.

The Prussians have already adopted this system; they carry *in front* two ammunition pouches, capable of holding some thirty rounds each, whilst they carry another thirty rounds by way of reserve in their knapsacks.

It seems strange that the present lumbering cartouch-box, misnamed a "pouch," with its awkward position *in rear* of the back, is still retained to hamper and incommode the modern soldier, whose work will be very different to that which was performed by those that used it in the last and preceding century.

Another Committee has likewise been appointed *to give effect* to the recommendation of the first, as to the adoption in our army of breech-loaders, or, in other words, to determine the very important and difficult question—WHICH BREECH-LOADER shall be put into the hands of the British soldier?

Pending, however, the decision,—which it will obviously require some time to make, and still longer to give effect to in the shape of a new armament,—it appears that Lord De Grey contemplates the "conversion," or, as the French call it, the "transformation" of a number of Enfield rifles into breech-loaders; and has actually advertised for the best means of doing so, under the condition that the cost per rifle should not exceed £1, and that the shooting of the transformed weapon should not be inferior to that of the unaltered arm, awarding at the same time to each competitor £20 as compensation for the cost of pattern, together with one thousand rounds of ammunition suited for the arm so converted. No doubt this can be done; indeed the problem has in a manner been already solved in the Mont-

* In a letter to the "Times" (28th December, 1860), on "Military Organization," the author pointed out this necessity, and suggested means by which the necessary reform could be effected without increasing the *impedimenta* of an army to any material extent.

A letter by an Englishman in the service of the Confederate States appeared the other day (in the "Times"), in which the writer, after cleverly expatiating on the advantages of breech-loaders, and the fact that the Confederates, as fast as they captured rifles in the field, converted them into breech-loaders, states his opinion that the 60th Rifles, if armed with breech-loaders, could destroy the brigade of Guards in fifteen minutes, little knowing that as at present constituted, and armed with the Whitworth rifle, the 60th actually carry more weight, man for man, than either a Guardsman or a Linesman. So much for our *heavy* (pseudo) "Light" Infantry.

Storm rifle (the great objection to which, we may remark parenthetically, consists in having the hinge of the breech-piece *in front* of the charge, vide Figs. 21—23), and there are, we believe, some dozen other known designs for the desired conversion.

In thus attempting to utilize the rifle we have, Lord de Grey is doubtless actuated, first, by reasons of an economical kind, and, secondly, by his desire to supply the army *at once* with a breech-loader, even though in the shape of a makeshift, pending the discovery of a more perfect form of breech-loading rifle. But while doing full justice to his motives in taking such a step, we are inclined to doubt its wisdom. Makeshifts are bad at the best, as sportsmen and riflemen well know; and a makeshift on which the prestige and safety of the empire may depend would be worse than all.

There are numerous serious objections to it. The expense of the conversion will of course ultimately have to be added to the cost of new breech-loaders for the army, so that in this sense it may be said to be "penny wise and pound foolish." Again, even at the best, an Enfield Rifle does not last longer than ten years; but in reality its life as a *rifle* is much shorter: so that in seeking to adapt a breech-loading system to it may be said to be "throwing good money after bad." The weapon has been condemned by an Ordnance Select Committee, and to all intents and purposes it cannot bear comparison, as a military weapon, with others with which it was tested by the Committee in question. Its day is gone; its glass is run; let it rest in peace; having done what it could in one stage of its existence, let us not vainly torture it into a metamorphosis, to which all the heathen gods together could not give congruity. "New wine in old bottles" would be nothing to the idea of turning the present condemned Enfield into the Enfield of the future.

Again, it will be a difficult matter, at the rate per rifle stipulated, so to alter the rifle as to dispense with the percussion-cap system, on the manifold disadvantages of which we have enlarged; and, finally, by retaining the Enfield-bore we sacrifice one of the great gains secured by the breech-loading rifle, namely, that a very small bore may be used, with its concomitant advantages of increased range, penetration, and accuracy, *without* any of the disadvantages which the use of a smaller calibre than ·50 in. involves in a muzzle-loader in the shape of difficulty in loading and accumulation of fouling, &c.

This is a point which appears to have been entirely lost sight of by Major-General Boileau in his remarks at page 406, as to the applicability of the Whitworth or Lancaster small-bore to a military breech-loader. Indeed what he there doubts as feasible has actually been accomplished; for, as everybody knows, the Westley Richards' breech-loader has a barrel on the Whitworth principle; indeed it is patented as such.

It is not a little mortifying to our national pride to hear on all occasions of this kind the reiterated remark that they manage these matters differently and better across the Channel; but better this than that we should delude ourselves into a vain notion of superiority in such matters. For several years past experimental breech-loaders

have been tried and tested at the great school of musketry at Vincennes; and in the weapon and ammunition recently served out to the Cent Gardes, the French Emperor appears to have found a breech-loader with which he is satisfied, and so we find that the other morning an imperial order made its appearance, in which it is decreed that *the whole* of the army of France will henceforward be furnished with a small-bore breech-loader (·30, we understand, is the calibre), the cartridge to contain its own ignition.

There is no compromise here—no half-measure. France has had enough of musket-"transformation," and found it a very sorry makeshift; and so the chances are now that the greater portion of the French army will be supplied with breech-loading rifles of surprising efficiency, before we have even commenced the transformation of what the volunteers—perhaps too disparagingly—term "a gas-pipe."

Would it not be well for us to follow so good an example, and instead of tinkering up our old barrels with new breech-pieces, rather at once discontinue the further manufacture of the muzzle-loading Enfield (at present going on as fast as ever), and direct at once our energies and resources to the construction of a good breech-loader, to be served out gradually to the army as the present arm wears out, or as fast as the new arm is ready to relegate the old one to the ranks of the Militia or Volunteer forces?

Be this as it may, however, the momentous question for our service still remains to be answered—*which breech-loader* shall we adopt?

The elucidation of this matter will doubtless occupy the Ordnance Committee for many months (*query*, years?) to come, unless, indeed, the National Rifle Association come to their assistance and settle the matter off-hand.

We may be permitted in the meanwhile to say, that we cannot see why the Association should at all continue the custom of having a competition for *muzzle-loading rifles*—as it proposes, we observe, for November next—under the present circumstances of the universally admitted breech-loading superiority, and since the British army is to be furnished with breech-loaders. It appears to us that the Association might just as well endeavour to elicit the best *long bow* as the best muzzle-loader now, for all purposes of practical utility.

In this breathless age it seems almost like plunging into antiquity to recall the late Wimbledon gathering, yet we must refer here, however briefly, to what undoubtedly formed the most important portion of the programme at that meeting, we mean of course the competition for the prize of £100, given by the Marquis of Tweeddale, for military rifles carrying ·550 ammunition. With a view of attracting the best weapons in either class the money offered was divided as follows:—£50 open to muzzle-loaders, and £50 open to breech-loaders. The conditions under which the contest took place were well calculated to test the qualification of the respective rifles, the stipulation being that each competitor was to fire 100 rounds continuously on four successive days, at 500 yards, until 400 rounds should be expended,—at the termination of each day's shooting the rifle being locked up without having been cleaned, so as to test its shooting under all circumstances

—not merely when fresh from the factory, with every advantage in its favour—thus to demonstrate whether it would bear up against the disadvantages of active service with equal efficiency.

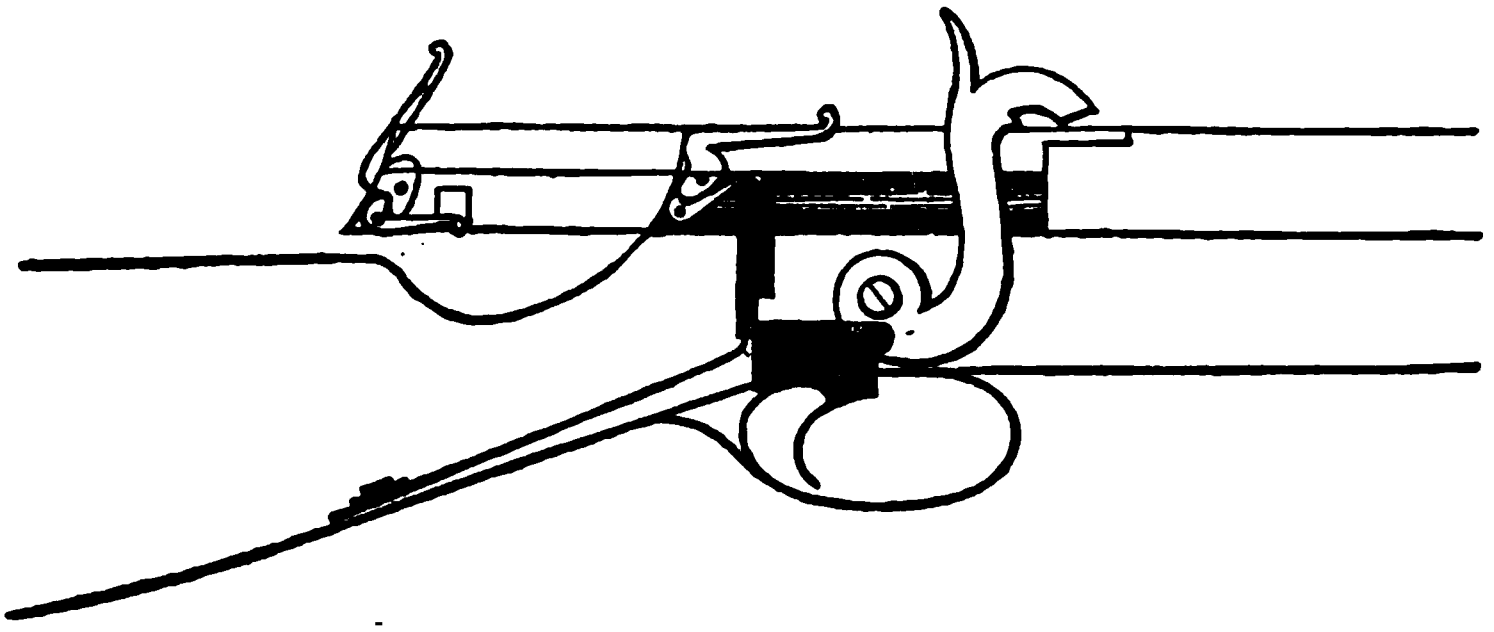
The prize for muzzle-loaders was won by a short large-bore Whitworth, which accomplished the following surprising and marvellous results:—Out of the 400 shots fired on four different days, 1,162 marks were scored, or only 38 marks less than an average of centres. The time occupied in making this splendid practice was 103 minutes, or within a fraction of 4 shots per minute. As this striking and insurmountable evidence of what can be done with a muzzle-loader is certain to be adduced in argument whenever the comparative merits of muzzle and breech-loaders are discussed in future, it is right to state that in the handling of Mr. Whitworth's rifle, the time occupied in loading was reduced to a *minimum* by the use of cartridges specially prepared. These were of a similar description to those patented for use with his small-bore rifle, save that they were made of the regulation size. A paper cylinder contains both the powder and bullet in the order in which these are to descend into the barrel. The bullet acts as a plug at one end of the cylinder; at the other the powder is confined by a little calico and pasteboard slide, which can be pulled away the moment the cartridge case is placed on the top of the barrel. A single downward motion of the ramrod through the cylinder sends the bullet home after the powder; the cartridge case then slips off over the head of the ramrod, and this there is never any occasion to turn, because the point, hollowed slightly into the shape of a cup, gives all the force that is necessary to the charge in ramming home, and immediately that the rod is withdrawn from the barrel it is in the right position to be thrust into the stock.

Mr. Whitworth was also fortunate in his representative Mr. Leece, whose steadiness, quickness, and confidence of aim were very remarkable. This explanation does not involve any disparagement of Mr. Whitworth's rifle. On the contrary, it shows, that having made up his mind to forward what he believed to be the best weapon, he took care to surround it with the best appliances; it proved the great practical utility of such competitions, and elicited the fact that we had much to learn even as to muzzle-loaders. However, their *rivals* and successors *in esse* are what most concerns us on the present occasion, and we therefore turn to the results of the *breech-loading* competition.

The rifle that won that prize was made by Mr. Henry, gunmaker, of Edinburgh. Its mechanism may be briefly described as follows: the breech (upper part) acts as a plunger, the back part of it having a double eccentric lever, whilst the front part has a peculiarly inclined face, formed out of the solid steel, which *rights* the position of the cartridge, carries it into the chamber of the barrel, and also extracts the empty cartridge-case on being opened again, and draws it out altogether.

The actual result of its practice on this occasion may be summed up as follows:—In the 400 rounds fired, 1,080 marks or points were made in 68 minutes 32 seconds, giving a value to each shot of 2·7

points, and a rate per minute of 5·84, or nearly 6 shots, which is half the rapidity of the long-bow of our ancient British archers.



THE HENRY BREECH-LOADER.

In awarding the prize to Mr. Henry, the Council took occasion to remark that they did not, however, consider that this breech-loader met all the requirements of a military arm, and this is their reason for initiating with liberal foresight another contest for arms on this principle, the best arm to have £100, the competition to take place next February.

The breech-loader which came next to Henry's in point of merit, appears to have been one called the Snider rifle, closely resembling in principle the Prussian needle-gun. It exceeded the Henry rifle in rapidity of loading, but fell far short of it in point of accuracy.

In conclusion, we have only to remark that the only real difficulty remaining to be overcome in the development of a thoroughly efficient breech-loader for military purposes is in the cartridge itself, the best ammunition being almost a harder problem than the best arm. Those who use breech-loaders over the stubble, or in the forest, have, of course, over and over again congratulated themselves on having at length obtained a cartridge which entirely does away with the "bother of caps." Hitherto, as we have already mentioned, the authorities have studiously (for prudential reasons, no doubt) set their face against the use in the army of a cartridge which shall combine such elements of danger as the presence of the percussion powder, as well as that of the villainous saltpetre. It is obvious that the brass pin which stands out at the right angles of the cartridge (in the Henry breech-loader and in the cartridge for breech-loading fowling-pieces in general), and the blow on which causes the ignition of the fulminating powder, would be extremely likely to be bent from its position, or forced out altogether in the rough handling to which it would be subjected in a campaign.

In the American invention, to which we have referred at page 405, it seems this obstacle of facile derangement is completely obviated. The cartridge is to all appearance similar to that in ordinary use (with sporting breech-loaders), save that it is without the "pin." But a slight beading runs round the circumference of the copper capsule,

which forms the base of the cartridge, and the inside of this rim or periphery is lined with a paste of the fulminating powder, and thus the hammer especially formed for the purpose, striking it through the aperture in the barrel where the pin would have otherwise protruded, on any portion of its surface, will ignite the charge. The likelihood of the derangement referred to above is thus remedied, and there is a minor difficulty (but still a difficulty) also superseded—that of its being necessary to insert the cartridge into the barrel with the pin accurately fitting the groove prepared for it. There is also another advantage claimed for this cartridge. It is asserted that nothing but the peculiar action of the hammer will ignite it. A number of them have been shaken violently together, struck, and thrown down with force on stones, and generally subjected to an elaborate course of rough treatment, with the determined intention of accomplishing their explosion, but all to no purpose. The inventors explain that to do so requires a squeeze as well as a sharp blow, and that, unless the cartridges be inserted in a close-fitting barrel, their elasticity preserves them from the combination of the two.

They are professedly water-tight, and impervious to fire. I have certainly seem some, round which gunpowder has been exploded, apparently quite uninjured.

Mr. Westley Richards, who, by the way, did not enter into the competition for the Marquis of Tweeddale's prize, is engaged, at the request of the Government, in making a breech-loading arm, with a cartridge to contain its own ignition, although he does not appear to be very sanguine as to the result, on account of the expense of the copper case, and the difficulty of extracting such a cartridge after firing from the *small-bore* rifle.

For our own part, we are inclined to believe that this difficulty will eventually find its solution in that wonderful material gun-cotton, 1 drachm of which is capable of effecting as much as 3 drachms of gunpowder, and that too with far less recoil, and a perfect immunity from smoke and fouling.

Experiments made by the Austrian committee proved that 100 rounds could be fired with gun-cotton, against 30 rounds of gunpowder. From the low temperature produced by gun-cotton, the gun does not heat. Experiments showed that 100 rounds were fired with a 6-pounder in 34 minutes, and the gun was raised by gun-cotton to only 122° Fahrenheit, whilst 100 rounds with gunpowder took 100 minutes, and raised the temperature to such a degree that water was instantly evaporated, therefore considerably above the boiling point, or 212°. The firing with the gunpowder was, therefore, discontinued; but the rapid firing with the gun-cotton was continued up to 180 rounds, without any inconvenience. The absence of fouling allows all the mechanism of a gun to have much more exactness than where allowance must be made for fouling. The absence of smoke promotes rapid firing and correct aim. There are no poisonous gases, and the men suffer less inconvenience from firing in casemates, under hatches, or in closed chambers. The fact of smaller recoil from a gun charged with gun-cotton is established by direct experi-

ment; its value is *two-thirds* of the recoil from gunpowder—projectile effect being equal. To understand this may not be easy, unless it results from the greater rapidity of its entire ignition; whilst that of gunpowder, strictly speaking, takes time, the ignition of gun-cotton is instantaneous throughout the mass, and the known causes of recoil with gunpowder are modified accordingly.

The great fact of the instantaneous ignition of gun-cotton, and the generation of all the gas, *before motion commences*, are, it seems, sufficient to account for diminished recoil in the piece.

The comparative advantages of gun-cotton and gunpowder for producing high velocities are shown in the following experiment with a Krupp's cast-steel gun, a 6-pounder. With the ordinary charge, 30 ounces of powder produced 1,338 feet per second. With the charge of $13\frac{1}{2}$ ounces, gun-cotton produced 1,563 feet. The gun may be made shorter; less weight, therefore, to drag, and less difficulty in the working. As to the advantage in weight of gun, the fact of the recoil being less in the ratio of 2 to 3, enables a less weight of gun to be employed, as well as a shorter gun, without the disadvantage to practice arising from lightness of gun.

As regards durance of gun, bronze and cast-iron guns have been fired 1,000 rounds without in the least affecting the endurance of the gun.

As regards conveyance and storage of gun-cotton, it results from the fact that 1lb. of gun-cotton produces an effect exceeding 3lbs. of gunpowder in artillery, that the difficulty of transport will be diminished, and much less room will be required for ammunition. This is an immense advantage, whether it is carried by men, by horses, or in waggons.

It may be placed in store, and preserved with great safety. The danger from explosion does not arise until it is actually *confined* in the requisite space.

It may become damp, and even perfectly wet without injury, and may be dried by mere exposure to the air. This is of great value in ships of war—in case of danger from fire, the magazine may actually be submerged, without permanent injury to the ammunition.

Gun-cotton positively keeps the gun clean, and requires less windage, and therefore performs better in continuous firing. In gunpowder there is 68 per cent. of refuse, or the well-known matter of fouling. In gun-cotton there is no residuum, and therefore no fouling, so that the present elaborate instruction in "cleaning arms" will be at once reduced to a *minimum*, if not annihilated so far as the rifle-barrel is concerned.

Each gun and each kind of projectile requires a certain density of cartridge. Practically, gun-cotton is most effective in guns when used as one-fourth to one-fifth of gunpowder, and occupying a space of $1\frac{1}{10}$ of the length of the powder cartridge.

The mechanical structure of the cartridge is of importance as affecting ignition. The cartridge is formed of a mechanical arrangement of spun cords, and the distribution of these, the place and manner of ignition, the form and proportion of the cartridge, all affect the time of complete ignition. As a cartridge, gun-cotton has to be enclosed in

a manner to prevent its compression, and give it a certain amount of space to do its work. Indeed its gradual instead of instantaneous combustion is altogether dependent on this point being attended to, for whereas the running down or compression within certain limits of gunpowder is essential to its effective action, any such process is fatal to that of gun-cotton, in other words gun-cotton must be simply transferred to the breech of the gun, so as to retain its normal formation or natural degree of textile expansion.

For this purpose, the cartridge, or muzzle-loaders, can either be made up in a strong, hard pasteboard tube, so as to prevent its compression; or the simple cotton-yarn may be wound round a thin-hollow wooden tube like thread on a bobbin, with a sufficient cylindrical thickness to fill the chamber of the gun.

The drawback to this is, as was found during experiments with gun-cotton at Hythe, that the charred remnant of the wood or paper is apt to remain in the barrel, to the detriment and danger of subsequent firing.

The necessity for maintaining the gun-cotton spread out or expanded to the full room it requires, which acts so awkwardly and disadvantageously in a muzzle-loader, becomes of little or no consequence in a breech-loader, in which the chamber intended for the reception of the charge can be so arranged as to permit the gun-cotton to be placed quietly in its appropriate receptacle, without being further interfered with till the moment of final discharge. It is by the complete mastery he has gained over all these minute points, that General von Lenk is enabled to give to the action of gun-cotton on the projectile, any law of force he pleases.

Finally, its cost of production is considerably less than that of gunpowder, the price of quantities which will produce equal effects being compared.

Having thus stated some of the mechanical properties of gun-cotton as an explosive agent, we cannot do better, in conclusion, than answer the question which will not unnaturally present itself to some readers, viz., what *is* gun-cotton, considered chemically?

Gun-cotton, or pyroxilin (*pyr*, fire, and *xylon*, wood) as it is generically termed, was invented in 1846 by the German chemist Schönbein; and although the announcement produced considerable sensation at the time, it had, until recently, ceased to occupy the minds of those whom the invention chiefly concerned—the military profession. "Punch," indeed, gave significance to it by figuring a meeting between Guy-Fawkes and Schönbein on Westminster Bridge; the former regretting that the latter had not been his contemporary with his invention. Certainly there might have been no "joke" in the matter, at the present day, about "the Plot," had gun-cotton been at the disposal of the arch-conspirator.

The "report," like all other reports, died away; and gun-cotton, far from being generally applied even to mining operations, was merely made the substance of a thick mucilage, dissolved in ether, to serve by way of sticking plaster. Subsequently, however, photography took it in hand, and found its ethereal solution a perfect means of

presenting to light the sensitive surface for the production of its beautiful pictures; for the collodion of the photographers is merely gun-cotton dissolved in sulphuric ether, and mixed with an iodide, which by being immersed in a bath of nitrate of silver, becomes iodide of silver, the most sensitive to light of all substances as yet discovered.

The recent Austrian Commission, and the conclusive investigations of Baron von Lenk, have completely restored to this giant of the chemist's laboratory its "proud eminence;" and, like gunpowder of old, after having been used for every purpose but the right one, in our *professional* point of view, it now finds itself exalted to the position of the most available agent for the purposes of warfare.

The manufacture of gun-cotton is one of the simplest manipulations of the laboratory. First, make a mixture of equal measures of strong nitric acid (sp. gr. 1·5), and sulphuric acid (sp. gr. 1·845). Then take one part—say 1 oz.—of finely carded cotton-wool, and immerse it in 15 parts of the above mixture. Instantly great heat is generated by the chemical action which ensues, and therefore this is the ticklish point of the manufacture. The cotton must be at once completely immersed in the mixture, otherwise it becomes so hot as to undergo immediate decomposition.

After a few minutes' immersion, the cotton must be taken out and plunged into a large volume of cold water, and then carefully washed in other water, until the mass ceases to show the slightest acid re-action when touched by litmus paper or placed upon it. It must then be carefully dried. Of course it will dry of itself in the air; but at all events, if artificial heat be used for the purpose, it must not exceed 170°.

Such is gun-cotton; and it is evident to the reader that it contains all the elements of gunpowder; the *nitre* of the nitric acid, the *sulphur* of the sulphuric acid, and the *carbon* (or "charcoal") of the cotton; its explosive or detonating property can therefore be readily conceived.

Tow, linen, paper, nay, even *saw-dust*, may be used instead of cotton; and in the last case it is evident that gun-cotton might be made to assume the form of *powder*, and so perhaps become more convenient for military purposes. The wood best suited for the manufacture of gunpowder might be treated in this way with the view of testing the feasibility of the suggestion, which we submit to the manufacturers.

The chemical change develops new properties in the substance; the cotton fibre increases more than 80 per cent. in weight; although differing very little in appearance from unchanged cotton, it may be distinguished from it by its harshness to the touch, by the crepitating sound which it yields when pressed by the hand, and by its *electric* [illegible] The only certain means, however, of distinguishing the [illegible] substance from ordinary cotton, is by the chemical action of [illegible] dissolved in a solution of iodide of potassium. When the [illegible] is moistened with this iodine solution, and a little sulphuric [illegible] added (one part of acid to four of water), a *yellow*

colour is evolved; whilst ordinary cotton, when similarly treated, assumes a *blue* colour.

In the open air gun-cotton burns with a flash, but without smoke or report; and a temperature of somewhat less than 400° is sufficient to ignite it, being 200° less than that required to ignite gunpowder. Authorities, however, differ very much as to the required temperature, which seems to vary with the mode in which the gun-cotton is prepared. Some specimens have exploded when being dried at a temperature of not more than 132°.

Up to the publication of the Austrian Report, the real properties and effects of gun-cotton were little understood. It can be exploded in any quantity instantaneously. This was considered its great fault; but it was only a fault when we were ignorant of the means to make that velocity anything we pleased. General von Lenk has discovered the means of giving gun-cotton any velocity of explosion that is required, by the mere mechanical arrangements under which it is used. In his hands, gun-cotton has any speed of explosion; from one foot per second, to one foot in the *one-thousandth* of a second, or to instantaneity.

The instantaneous explosion of a large quantity of gun-cotton is made use of when it is required to produce destructive effects on the surrounding material. The slow combustion is used when it is required to produce manageable power, as in the case of gunnery.

It is plain, therefore, that if we can explode a large mass instantaneously, we get out of the gases so exploded the greatest possible power, because all the gas is generated *before motion commences;* and this is known to be the condition for maximum effect. The great waste of gunpowder is almost ridiculous; it is positively 68 per cent. of its own weight, and only 32 per cent. is useful. Moreover, this 68 per cent. is not only waste in itself, but it wastes the power of the remaining 32 per cent. It wastes it mechanically, by using up a large portion of the mechanical force of the useful gases. The waste of gunpowder issues from the gun with much greater velocity than the projectile; and if it be remembered that in 100lbs. of useful gunpowder, this is 68lbs., it will appear that the gas of 32lbs. of useful gunpowder is wasted in impelling a 68lb. shot; the power resulting merely from the refuse of gunpowder!

It is found that the condition necessary in gun-cotton to produce instantaneous and complete explosion, is the absolute perfection of closeness in the chamber containing the material. The reason of it is, that the first-ignited gases must penetrate the whole mass of the cotton; and this they certainly do, and effect complete ignition throughout, only *under pressure.* This pressure need not be great. For example, a barrel of gun-cotton will produce little effect, and very slow combustion, when out of the barrel, but instantaneous and powerful explosion when shut up within it.

On the other hand, if we desire gun-cotton to produce mechanical work, and not the destruction of materials, we must provide for its slower combustion. It must be distributed and opened out mechanically, so as to occupy a larger space, and in this state it can be made to act

even more slowly than gunpowder, and the exact limit for purposes of artillery General von Lenk has discovered by critical experiments. In general it is found that the proportion of 11lbs. of gun-cotton, occupying one cubic foot of space, produces a greater force than gunpowder, of which from 50 to 60lbs. occupies the same space, and a force of the nature required for ordinary artillery.

For artillery, gun-cotton is used in the form of thread or spun-yarn. In this simple form it conducts combustion slowly in the open air, at a rate of not more than one foot per second. This thread is woven into a texture or circular web. The webs are made of various diameters, and it is out of these webs that common rifle cartridges are made, merely by cutting them into proper lengths, and inclosing them in stiff cylinders of pasteboard, which form the cartridges. In this shape its combustion takes place at the speed of 10 feet per second.

In these cylindrical webs it is also used to fill explosive shells, as it can be conveniently employed in this shape to pass through the neck of the shell.

Gun-cotton thread is spun into ropes in the usual way up to two inches in diameter, hollow in the centre. This is the form used for blasting and mining purposes; it combines great density with speedy explosion.

The gun-cotton yarn is used directly to form cartridges for large guns by being wound round a bobbin so as to form a spindle, like that used in spinning-mills. The bobbin is a hollow tube of paper or wood. The object of the wooden tube is to secure in all cases the necessary length of chamber in the gun required for the most effective explosion. The gun-cotton circular web is inclosed in close tubes of india-rubber cloth, to form a match line, in which form it is most convenient, and travels with speed and certainty. In large quantities, for the explosion of mines, it is used in the form of rope, and in this form it is conveniently coiled in casks, or stowed in boxes.

As regards the practical application of gun-cotton to the destructive explosion of shells, it appears that, from a difference in the law of expansion, arising probably from the pressure of water in intensely heated steam, there is an extraordinary difference of result, namely, that the same shell is exploded by the same volume of gas into more than double the number of pieces. This is to be accounted for by the greater velocity of explosion when gun-cotton is confined very closely in very small spaces. It is also a peculiarity that the stronger the shell the smaller the fragments into which it is broken.

In mining operations, the fact that the action of gun-cotton is violent and rapid in exact proportion to the resistance it encounters, tells us the secret of its far higher efficacy in mining than gunpowder. The stronger the rock, the less gun-cotton, comparatively with gunpowder, is necessary for the effect; so much so, that while gun-cotton is stronger than powder as 3 to 1 in artillery, as before stated, it is stronger in the proportion of 6·274 to 1 in a strong and solid rock—weight for weight. It is the hollow rope form that is used for blasting. Its power of splitting up the material is regulated exactly as wished.

With respect to military and submarine explosion, it is a well-

known fact that a bag of gunpowder nailed on the gates of a city will blow them open. In this case gun-cotton would certainly fail; a bag of gun-cotton exploded in the same way is powerless. If one ounce of gunpowder is exploded in scales, the balance is thrown down; with an equal force from gun-cotton nothing happens. But to blow up the gates of a city a very few pounds of gun-cotton, carried in the *hand of a single man*, will be sufficient, only he must know its nature. In a bag it is harmless; exploded in a box it will shatter the gates to atoms. Against the palisades of a fortification a small square box, containing 25 lbs., merely flung down close to it, will open a passage for troops. In actual experiment on palisades, 1 foot in diameter, and 8 ft. high, piled in the ground, backed by a second row of 8 inches diameter, a box of 25 lbs. of gun-cotton cut a clean opening 9 ft. wide. In this case three times the weight of gunpowder produced no effect whatever, except to blacken the piles.

Against bridges it is equally formidable. A strong bridge of oak, 24 feet span, was shattered to atoms by a small box of 25 lbs., laid on its centre. The bridge was not broken, it was literally shivered.

The effects of gun-cotton under water are not less striking and conclusive in its favour, as compared with gunpowder. In the case of two tiers of piles, in water 13 feet deep, 10 inches apart, with stones between them, a barrel of 100 lbs. of gun-cotton, placed 3 feet from the face, and 8 feet under water, made a clean sweep through a radius of 15 feet, and raised the water 200 feet. In Venice, a barrel of 400 lbs., placed near a sloop in 10 feet water, at 18 feet distance, flung it in atoms to a height of 400 feet!

All the experiments made by the Austrian Artillery Commission or Committee were conducted on a grand scale, 36 batteries, 6 and 12-pounders (for gun-cotton) having been constructed and practised with that material. The reports of the Commissioners are all based on trials with ordnance, from 6-pounders to 48-pounders, smooth bore and rifled cannon.

Such then are the properties and effects of gun-cotton. We are aware that exceptions may be taken as to certain parts elicited and claimed as advantages in the new material as an agent in warfare, such as the diminished heat of the gas and the shorter gun required.

Thus we learn in a recent investigation, conducted at the French Academy of Science by M. Pelouze, one of the chemists who wrote a report against gun-cotton in 1849, in conjunction with a M. Maurey, with the view of testing the value of General Lenk's process of manufacturing gun-cotton compared with that in France, that while admitting a difference of chemical composition between the two varieties, they affirm that all their specimens of his cotton exploded at a temperature of 180° Fah., and that at temperatures as low as 99 Fah., decomposition ensued with equal certainty, but only in the course of a few hours, and in one case they even obtained an explosion at 83°, which induced them to "suspect" that it may even be decomposed at the ordinary temperature.* Yet in the face of such a

* This spontaneous decomposition passes through four different stages. At first it contracts slowly without losing its primitive form and texture, so that its volume

conclusion, they admit that General Lenk had been able to fire 1,000 rounds in quick succession from a piece of ordnance without spoiling the bore of the gun, or without any apparent tendency in the gun-cotton to ignite spontaneously from the high temperature to which the gun-metal assuredly must have been raised after so many quick successive discharges. Facts are stubborn things, and if such as have here been quoted can be established by the Austrian Commission, it will be futile to "reason" them away, for, as Galileo says, "when we have the decrees of nature, authority goes for nothing." Preconceived, scientific inductions, based on the action of gunpowder gas, cannot be quoted in opposition to the facts established on gun-cotton.

The expansive and motive force of gunpowder is doubtless materially connected with its heat, but facts seem to prove that this is not a condition so essential in gun-cotton; and the learned objectors should rather try and find out the reason for the apparent anomaly, than preach it as an impossibility, from a text recorded under a different dispensation.

The same remark applies to the shortness of gun required for gun-cotton. Beyond a certain limit, it is certain that length of gun is a disadvantage; and accepting the facts of the Austrian Commission, we do not see that the objection opens any other question than the adequate length of gun for maximum effect.

It is satisfactory to know that at their last meeting (1863) the British Association passed a resolution urging the Government to appoint a commission, by means of which a more complete investigation—and such as the subject unquestionably deserves—may be made and practically applied. This recommendation has not been without its effect, and we rejoice to find that the War Office has appointed a committee on gun-cotton, with the President of the Royal Society as chairman, and that they have instituted a number of experiments, which are to demonstrate the superiority of gun-cotton over gun-

becomes ten times less than its original one. A few days later it becomes soft, and is transformed into a sort of gummy matter which adheres strongly to the fingers, and has no longer any appearance of texture or organization whatever, even when viewed through the microscope. When this mass has become quite homogeneous, its volume is again reduced by one-half. The third stage, which occurs some considerable time after, instead of producing any further contraction, causes an expansion, so that the substance, reduced as it is to one-nineteenth of its original volume, swells up to the full extent of the latter. In this state it is still gummy, but the mass is porous, and full of cavities like a sponge. During these three stages there is a constant evolution of nitrous vapours, which become much more abundant during the third stage. This evolution of gas gradually diminishes during the fourth stage; the substance slowly loses its gummy quality and yellowish colour, and becomes so friable as to admit of being crushed into powder between one's fingers; it then becomes as white as sugar. It takes at least five months to see all these stages passed through. The sugary substance is very acid, nearly entirely soluble in water, and is composed of glucose, gummy substances, oxalic acid, a little formic acid, and another which M. de Luca thinks is new, and with which for the present he has obtained salts of lead and silver. The glucose contained in this last transformation of gun-cotton has the taste and even the flavour of honey; it quickly reduces the tartrate of copper and potash, and ferments in contact with yeast, producing carbonic acid and alcohol. It appears from M. de Luca's experiments that gun-cotton will keep indefinitely in vacuo.

powder, not only for war, but for industrial purposes. The cotton has been tried in one of the mining districts of Wales, and is now undergoing trial in the lead-mines of Allenheads, in Northumberland; while the gun-cotton factory at Stowmarket is kept busy with the manufacture.

Whatever has been done up to this time, it is to be hoped that England will not remain behind-hand in a matter of such great and national importance, for we have no hesitation in maintaining that the introduction of gun-cotton into warfare will effect as great a revolution as that produced by gunpowder of old.

Compared with the latter, in its beginning, gun-cotton is a *perfect* thing, of which we have become possessed—completely meeting all our present difficulties, supplying all our wants, and giving the last perfection to the soldier's weapon. Surely, the high exaltation predicted by Robins of old to "the state that shall thoroughly comprehend the nature and advantages of rifled barrel-pieces, and having facilitated and completed their construction, shall introduce into its service their general use, with a dexterity in the management of them"—is even more applicable to this wonderful invention, which is now offered by science and art to warfare, in order to make it sharp, short, and decisive.

And then? Well, then possibly "the goal of yesterday will be the starting point of to-morrow." The ordinary breech-loader may eventually have to make way for a breech-loading *revolver* (or what the Yankees term "repeater"*), with an indestructible steel rifled-barrel, capable of letting one man do what it before required many more times that number to accomplish, in accordance with the universal tendency of our age to substitute mechanical means for manual.

But for a time, at least, a good breech-loader, with gun-cotton, will be, if not perfection in the fire-arm, the nearest approximation to it we can hope at present to attain. Imagine the future battle-field unclouded with smoke—clear as the hand-to-hand encounters of the ancient warriors, who never lost sight of their enemy. Then, indeed, our tactics will have to be modified, if we are to play our part successfully on the battle-fields of Europe or America—battle-fields which will probably become more bloody than ever.

But we must not permit these facts and hopes held forth by this new agent of destruction to produce any present stagnation in our efforts for advancement; but rather, content with the materials thus far practically placed within our reach,

"Forward! forward let us range!"

* In accounts recently brought from America, it is distinctly stated that some Federal cavalry regiments are armed with *sixteen-shooter* rifles! (equivalent to a sixteen-chambered revolver); and, on the other hand, we learn that the Confederates have introduced a self-feeding rifle, the cartridges (containing their own ignition) being first placed in a receptacle hollowed out for them in the stock, and supplied in rapid succession to the barrel by the mere action of full cocking the piece. With such means of destruction, the American war must surely, ere long, bear some analogy to that waged by the Kilkenny Cats.—A.W.

DESCRIPTION OF BREECH-LOADERS ON PLATE XXXI.

WESTLEY RICHARDS'.

Fig. 8 represents cartridge inserted and breech closed.
Fig. 9 shows breech open to receive cartridge.
Fig. 10, appearance of rifle, with breech closed.

TERRY'S.

Fig. 11, side elevation of musket, with breech apparatus.
Fig. 12, breech apparatus, with cartridge inserted in barrel.
Fig. 13, breech apparatus detached, closed up to breech.
Fig. 14, enlarged view of breech apparatus.

GREEN'S.

Fig. 15, side view partly in section, showing breech apparatus.
Fig. 16, piston or bolt, and the cover of the breech chamber.
Fig. 17, transverse section of the cover of the breech chamber and piston, or bolt.
Fig. 18, end view of ditto.
Fig. 19, breech-plug loose in breech plate, which partly turns round in plate.
Fig. 20, side view, with breech closed, and ready for capping.

MONT-STORM'S.

Fig. 21, side elevation of Enfield rifle fitted with Mont-Storm's breech-loading chamber.
Fig. 22, breech raised, showing cartridge in chamber.
Fig. 23, side view, partly in section, showing position of breech at the moment of firing.

LIEUT.-COLONEL DAVIDSON'S PATENT TELESCOPIC RIFLE SIGHT.*

The telescopic sight for military and long range rifles patented by me may be described as follows:—

The telescope is contained in a strong steel tube, and is attached to the side of the rifle, so as to meet the eye in presenting; and is capable of being depressed to any required angle, according to the range.

A reference to the diagrams Figures 1 to 8 (Plate XXXII), which are on the scale of one-half, will explain how it is attached to the rifle, with its eye-piece pulled out to focus, and the telescope set for two degrees of elevation.

A and B are collars firmly fitted to the telescope, A at the object end, and B a few inches from the eye end. The front collar A is furnished with an arc C, divided from zero to 12 degrees of elevation. The exact shape of this collar will be seen from the other three views

* A paper contributed by Lieutenant-Colonel D. Davidson, 1st City Edinburgh Rifle Vols., and late H. M. Bombay Army.—Ed.

Fig. 1.

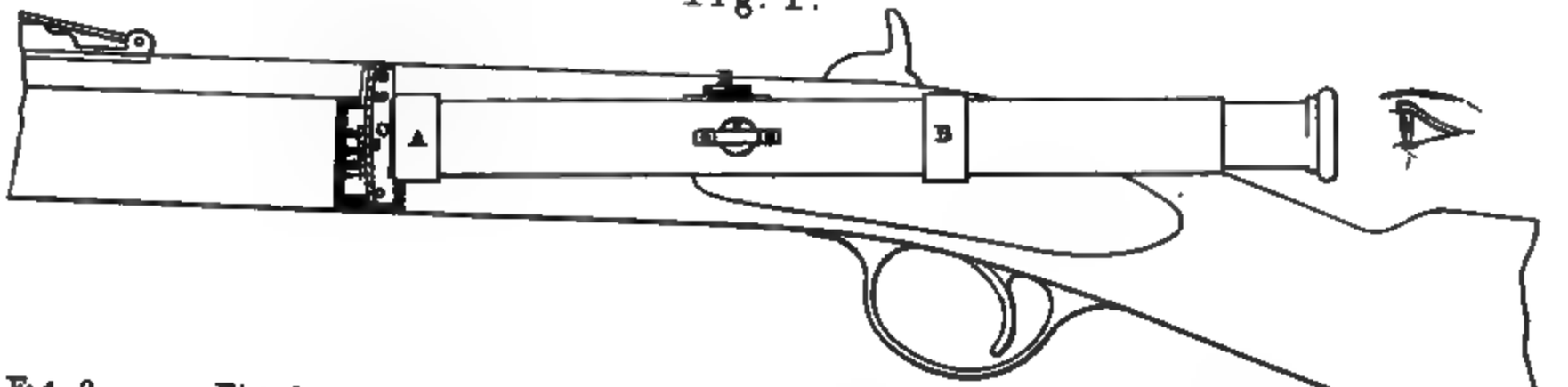


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

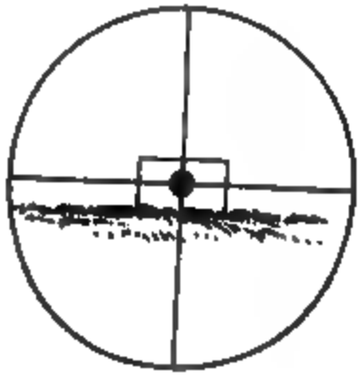


Fig. 10.

of it given in Figures 2, 3, and 4. The upper step of the arc is of white metal, and carries the scale.

Figures 5 and 6 give two views of the back collar, B, which has a rounded neck furnished with two feathers or projections. This neck forms the pivot on which the telescope turns. When the telescope is applied to the rifle at right angles to the barrel, the neck enters a hole (see Figure 7) in a plate substituted for the escutcheon plate of the hinder lock screw; and on the telescope being twisted down to a position parallel to the barrel, the feathers, or projections, lock into the inner surface of the escutcheon plate, and hold the telescope firm to the piece.

When the telescope is parallel to the barrel, the inner surface of the arc presses on a plate (shaded in Figure 1) let into the stock, and shown in cross section in Figure 8, also shaded with single lines. Through a square hole in this plate a clamping bolt, cross shaded in Figure 8, is passed through the stock under the barrel. The flat T-shaped head of this bolt which carries the vernier, overlaps the lower step of the arc in the manner shown by dots in Figure 3. When in this position the telescope is set to the required angle by means of the scale on the arc and the vernier on the cross head of the bolt, and it is there securely clamped and held to the piece by means of the milled nut D, Figure 8, on the opposite side of the stock.

When the line or arrow, the zero of the vernier, corresponds with the zero of the arc, the axis of the telescope is by construction exactly parallel to the axis of the barrel both in the horizontal and vertical plane—the constant parallel error involved by placing the axis of the telescope a little to one side of the axis of the piece is of no practical moment.

In the focus of the eye-piece of the telescope, cross lines are placed, the intersection of which, as seen in Figure 9, gives the aim, without its being necessary to see any muzzle sight.

The horizontal line can be raised or depressed for minute adjustment in elevation by turning the milled head E, Figure 1, and the vertical line may be moved to either side for correction for side wind, by the other milled head F, Figure 1.

Having described the telescopic sight, I shall add a few remarks on its peculiar advantages.

When we wish to survey some distant object with more than ordinary exactness, we have recourse to the telescope. A sportsman, in searching for deer, finds a telescope almost indispensable. Military riflemen, too, when engaged at long ranges, avail themselves of its aid. Of this we have a striking example in an incident which occurred in the rifle pits before Sebastopol. One soldier was observed lying with his rifle carefully pointed at a distant embrasure, and with his finger on the trigger ready to pull, while by his side lay another with a telescope directed at the same object. He, with the telescope, was anxiously watching the moment when a gunner should show himself, in order that he might give the signal to the other to fire.

Now it is an established fact to which I can speak from thirty years' practical experience, that by a simple mechanical arrangement such

as has been described, the same telescope which is so useful in searching out the object, can be turned to the best account in taking aim.

Though the present application, which renders the telescope available for the longest ranges, is new, the principle is no new thing, but has long been tested both in India and America. I cannot say how long the telescope has been used as a sight for rifles in America, but thirty years ago, which I rather think was anterior to its use in the New World, I introduced it into India, and used it, along with many other sportsmen, to whose rifles I applied it, with singular success against the antelope on the plains of the Deccan. It not only gives increased precision at long ranges, but it enables the sportsman to aim at deer and bustard, which, from the intervening grass and bushes, could not be sighted with the naked eye. More than once I have shot deer with considerable certainty, when I could see only the tips of their horns. On the first occasion of this kind, a gradual rise in the intervening ground hid the deer from my view; but catching the points of his horns in the field of my telescope, I knew the direction in which he stood, and imagining, as with the dotted line in Figure 10, the body of the antelope, I laid the intersection of my cross lines on the region of the heart and pulled. Immediately I heard the well-known thud. The bullet rose in its trajectory so as to clear the intermediate height, and dropping again, struck the deer close to the heart, and killed him on the spot.

Bustards, it is well known, when stalked, get behind the nearest bush, and think themselves secure. This was just the position in which, with the telescope rifle, I liked best to find them; for the telescope enabled me to trace the figure of the bird through the thin foliage of the babool bush; and at one place where they abounded, I shot as many as nine in succession under such circumstances as these, when the ordinary sight could not have been used.

I mention these facts to show the thoroughly practical character of the invention. There are gentlemen now at home and in India, who have used the same rifles to which I fitted telescopes, for more than fifteen years without their getting out of order. In this case the telescope, pulled on to dovetails, run into the barrel; but as it could not be depressed, it was suitable only for the comparatively short ranges required in deer-stalking; the patented telescope may be used at two miles.

The great optical difficulty which has to be contended with in any other mode of sighting but the telescopic, is that which arises from the fact that the eye cannot view with distinctness at the same moment two or more objects placed in a line, but at different distances from it. If one of those objects is looked at intently, the others become obscure. Now, in rifle-shooting with any of the ordinary sights, there are three objects to be brought into alignement, namely, the back sight, the fore sight, and the objects aimed at. In the process of aiming, then, the eye is constantly changing its focus, in its effort to bring these objects into line.

In the case of the telescopic sight, this difficulty is entirely obviated, for the simple reason, that the object aimed at, and the cross lines by

which it is to be intersected, which constitutes the aim, are optically at the same distance from the eye; and the one can be laid as easily upon the other, as I can place the point of my pen upon any spot on the paper before me. This, of itself, would be a great advantage, even if the telescope had no magnifying power, but when added to this it gives an enlarged view of the object, its superiority cannot be disputed.

This seems the proper place to notice what is perhaps the most important practical advantage possessed by the telescope over any other rifle sight in use. With all other sights, and with none more than with the aperture sight, it is requisite to have, what is never had in service, namely, a white target, and a clearly defined bull's-eye; with the telescope this is altogether unnecessary, for the aim can be taken as readily at a small stone or bush on the hill side, as at the blackest bull's-eye on the cleanest target.

A glance at any of the complicated long range sights in use will satisfy any one that they are utterly unfit for military purposes. Besides the difficulty just referred to of aiming with them at any of the objects usually met with in the field, they are from their construction peculiarly liable to injury. Standing up, as they do, above the barrel or the stock, they are much exposed, and their light frame and delicate hinges could not resist rough usage. On the contrary, the patented telescope lies close to the rifle, and is strong in its construction. It does not interfere with the use of the common military sight for close quarters, and it can be taken off or applied in a moment.

There is another practical advantage which must not be overlooked. In aiming at long ranges with any of the ordinary sights, it is necessary to raise the eye to an inconvenient height, and to support the check by an elevating check-piece; whereas with the telescope now described, 10 or 12 degrees of elevation may be given, without involving any sensible movement of the eye.

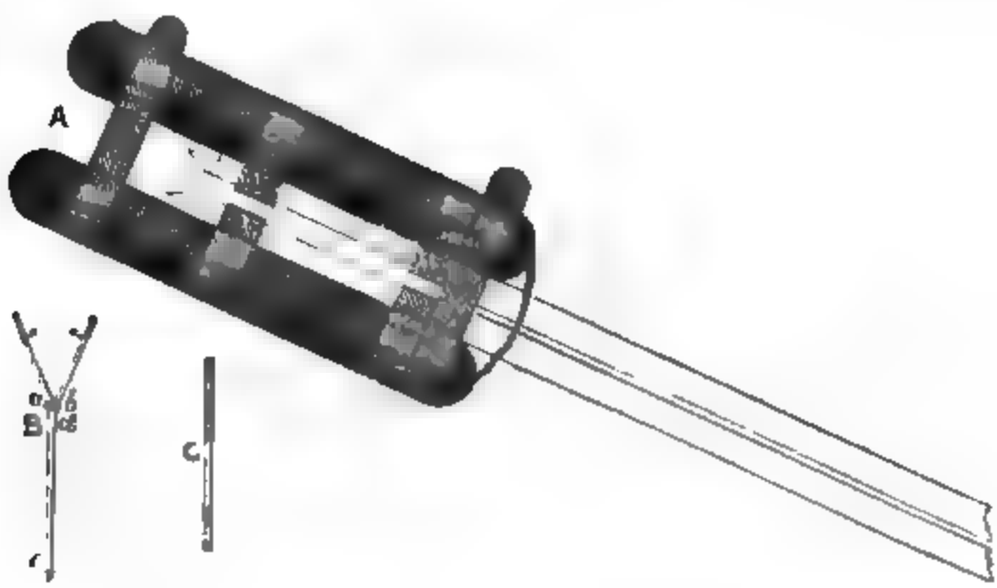
Rifles fitted with telescopes would be of great value in rifle-pits, in dislodging bushfighters, and in keeping down the fire of artillery. A heavy large-bore telescope-rifle, taking a large charge and throwing an exploding projectile, would be serviceable against field batteries at the longest ranges.

NEW LEADER FOR COUPLED ROCKETS.

Contributed by Lieutenant W. F. A. Harris, R.N., Coastguard, Grey-stones, Ireland.

The leaders now in use are very objectionable for several reasons; firstly, from the time wasted in fitting them to the rockets, as will be seen by reading the instructions for their use. "Take a leader and

"insert one of its legs into the mouth of the lower rocket, hook the "hook into the hole in the mouth of the case, and pinch the hook close "between the finger and thumb, take the other leg and insert it into "the mouth of the upper rocket, hook it into its place and close the "hook as before, lay the rockets into the frame, taking care not to "jamb the leader between the bottom of the rocket and the end of the "shaft of the frame inside, pass the loose end of the leader down "through the hole in the lock case, and insert the small end of the "percussion tube into the vent hole (for steadiness only) and close "the jaw upon the seizing where the paper joins the quill." I need hardly remark that, on a dark and cold night, and men likely to be excited at a wreck, there would be a great loss of time, perhaps under circumstances, where every minute would make a great difference in saving life. There also is no certainty in their firing the rockets, when you *have* got them in their places. My experience of them is, that the average, firing the rockets *simultaneously*, does not amount to more than one in four, the leader being generally blown off (without communicating the fire) at the parts marked a, b, c, d; then supposing one leg, say b, to be blown off, and the fire communicated to the one rocket only, by the other leg a, the one rocket has to do the duty of two, and consequently, with its double weight, falls into the water at a distance of about 20 yards. If it is blown off at c, the whole operation of hooking, &c., has to be gone through again with a new leader.



A. Coupled rockets, with leader entered ready for firing.
B. Leader now in use for firing coupled rockets.
C. Improved leader.

Having stated my objections to these leaders, I will proceed to state how my own act, so as to do away with loss of time, and to ensure the simultaneous firing of the rockets, without which a single rocket is much preferable to the coupled. My leader (C) is perfectly straight, and can be entered in a moment, even with one hand, the black end in the lower rocket, the other in the upper; it is then fired as a single

rocket. The fire from the tube ignites the lower rocket, and the leader instantaneously conveys it to the upper, thus insuring their going off together, and attaining the greatest range that can be got out of them; the figure A shows the leader entered and ready for immediate use. I enclose a copy of an extract of a letter from Captain de Courcy to the Commodore Controller-General on the subject, in which he says, "I have to report I witnessed a trial of them on the "3rd, when the line was thrown over the 'Stag' cutter. The leaders "supplied with the rockets often fail in conducting the fire, and are "liable to break at the joint. Lieut. Harris's leaders are easily made, "and much easier adjusted to the rockets than those supplied." This letter was dated March 7th, 1864. On March 14th the matter was forwarded to the Board of Trade, in whose hands it now is.

CALCULATION OF RANGE FOR THE SERVICE OF ARTILLERY.

A Paper contributed by Captain J. R. Campbell, Hants Artillery Militia.

That the course of a projectile is not a straight line, but a curve technically called its *trajectory*, is a fact known to every gunner and rifleman of the present day; and he learns from this that, in order to hit an object, he must give his gun a certain elevation depending on the distance he is from it, the nature of the gun and projectile, charge of powder, &c. Give him the distance or range, and he can, by the aid of certain rules or by reference to tables, ascertain the elevation required. In target practice, where the ground is measured out, this naturally ceases to be a matter of question; but in war, when firing at an actual enemy, or at his works, or ships, the range is seldom or never known. For short distances, and within certain limits of error, it may be *judged* by the eye, but for the higher artillery ranges, especially across water, this is impossible. Artillerymen generally depend upon their first shot or two—*trial shots* as they are termed—correcting each succeeding one by the result of the last, until they strike the object. But there are disadvantages attending this system, which is, besides, clumsy and unscientific. I will mention what I believe to be two.

1stly. In many cases, owing to the nature of the ground where the shots pitch, or other causes, it may be extremely difficult to observe the graze of the trial shots. We read of actions where at least the majority of the shots fired by one contending party have either all dropped short of, or all passed over, the heads of their adversary, and I ascribe this principally to the want of some better method of determining the range. The late engagement between the "Kersage"

and "Alabama" affords no bad illustration of the defects of the present system. Few of the "Alabama's" shots seem to have struck her adversary.

2ndly. During the time you are testing the elevation by trial shots, your enemy, supposing him to have found the range, may be destroying you with shot and shell.

I might, perhaps, also mention the expense of ammunition thus fired in vain, which, in the case of the colossal ordnance now fabricated, can be no trifle. It is said that one projectile from Sir W. Armstrong's 600-pounder would render a ship *hors de combat;* but to do this it must *hit* her, and, I presume, ought to strike close to her water-line; and although I grant that at very close quarters any calculation of the range would be unnecessary, yet cases might occur where our enemy, drawing less water, or steaming faster than ourselves, might be able to avoid this condition.

Now by means of trigonometry we have in most cases the power of measuring the range with sufficient accuracy for practical purposes. There are several ways of doing this; and the object of the present paper is to describe that which appears to me the simplest and most expeditious.

Suppose the distance A X (in the accompanying fig.) to be the range required. A base line A B = 100 units is measured from A at right angles to it. This (on land) may be done by pacing, or better by means of a chain or cord, the direction being taken by a pocket sextant set at 90°. A man or flag is placed at each of the points A, B, and the angle A B X measured by the instrument. Then we have

$$A\,X = 100 \text{ tan. } A\,B\,X$$

$$\text{or log. } A\,X = 2 + \text{log. tan. } A\,B\,X,$$

from which equation the distance A X may be calculated.

The following table is constructed for the purpose of showing at once the range subtended by an angle read off on the sextant, thereby avoiding such loss of time and trouble as would be required in working out the equation.

The 2nd column gives the ranges or values of A X expressed in units, corresponding to the values of the angle A B X placed opposite to them in the 1st column. The shorter ranges are computed for each successive 10′ in a degree, and the longer ones are taken at every 3′. The 3rd column contains the *mean* value of a minute for angles whose magnitude may lie between that opposite which it stands and the one below it on the table. I have adopted this arrangement in order to render the table concise and handy. It would be easy to construct one with the range expressed for every minute in a degree. I believe, however, the time required in finding the range of the intermediate angles will never exceed a few seconds.

TABLE.

Angle.	Range.	1′=	Angle.	Range.	1′=	Angle.	Range.	1′=	Angle.	Range.	1′=
78° 41′	500	·7	83° 15′	845	2·2	85° 40′	1,320	5·0	87° 15′	2,082	13·0
50′	506	·8	20′	856		45′	1,345	5·6	18′	2,121	
79° 0′	515		25′	866	2·4	50′	1,373		21′	2,160	13·3
10′	523		30′	878		55′	1,401	5·8	24′	2,202	14·0
20′	531	·9	35′	889		86° 0′	1,430	6·0	27′	2,246	
30′	540		40′	901		3′	1,448	6·3	30′	2,290	15·6
40′	549		45′	913		6′	1,467		33′	2,337	16·3
50′	558		50′	925	2·6	9′	1,486		36′	2,386	17·0
80° 0′	567	1·0	55′	938		12′	1,505	7·0	39′	2,437	17·6
10′	577		84° 0′	951	2·8	15′	1,526		42′	2,490	18·3
20′	587		5′	965		18′	1,547		45′	2,545	19·3
30′	598		10′	979	3·0	21′	1,568		48′	2,603	20·3
40′	609		15′	993		24′	1,589	7·6	51′	2,664	21·0
50′	620	1·2	20′	1,008		27′	1,612		54′	2,727	22·3
81° 0′	632		25′	1,023	3·2	30′	1,635	8·0	57′	2,794	23·3
10′	643	1·3	30′	1,039		33′	1,659		88° 0′	2,864	24·3
20′	656		35′	1,055		36′	1,683	8·3	3′	2,937	26·0
30′	669	1·4	40′	1,071	3·4	39′	1,708	8·6	6′	3,015	27·0
40′	683		45′	1,088	3·6	42′	1,734	9·0	9′	3,096	28·6
50′	697	1·5	50′	1,106		45′	1,761	9·3	12′	3,182	30·3
82° 0′	712		55′	1,124	3·8	48′	1,789		15′	3,273	32·0
10′	727	1·6	85° 0′	1,143	4·0	51′	1,817	9·6	18′	3,369	34·3
20′	743	1·7	5′	1,163		54′	1,846	10·3	21′	3,472	36·0
30′	760		10′	1,182	4·4	57′	1,877		24′	3,580	38·6
40′	777	1·8	15′	1,204		87° 0′	1,908	10·6	27′	3,696	41·0
50′	795	1·9	20′	1,225	4·6	3′	1,940	11·3	30′	3,819	43·6
83° 0′	814	2·0	25′	1,248		6′	1,974	11·6	33′	3,950	47·3
5′	825		30′	1,271	4·8	9′	2,009	12·0	36′	4,092	
10′	835		35′	1,295	5·0	12′	2,045	12·3			

Note.—The decimals in the values of 1′ for the higher ranges need seldom be taken into account, although I have thought it best to shew them.

The following examples will show the working of the table :—

1. Suppose the base to be 100 yards, and the angle 85° 36′, what is the range? For 85° 35′ the table gives 1295 yards, a yard being here the value of a unit, and we see that between the latter range and 1345, the minute corresponds to 5 yards. Hence, 1295 + 5 = 1300 is the range required.

2. Let the base be 50 yards, and the angle observed, 88° 23′. 3472 + 2 × 36 = 3544 would be the distance were the base 100 yards, *i. e.*, if, as in the last example, the unit were 1 yard. In the present case, the unit being half a yard, we must divide the above number by 2, and we get 1772 yards as the range required.

3. Let 200 yards be measured for a base, and suppose the angle = 88° 7′. The value for this angle given in the table is 3015 + 27

= 3042, but as the unit in the present case = 2 yards, we must multiply by 2. 2 × 3042 = 6084 yards is the distance sought.

The value of 1′ is a measure of the *error* in the observation arising from the fact of the sextant only reading to 1′. In the 1st example this error is *not greater* than 5 yards; in the 2nd it is at most equal to 18 yards, and in the 3rd does not exceed 54 yards. This error rapidly increases as the angle approaches 90°.

The above examples show how the same table may be made to serve for a base of any length. But for localities where only a shorter distance than 100 yards is available, it would be advisable to compute a table, on the same principle as that on the last page, to a base equal to the number of yards at command.

It can be readily shown, that if in measuring the base an error is made = d units, the error thereby resulting in R, the range, will be

$$\frac{R}{100 - d} \times d \text{ when the base} = 100 + d,$$

$$\text{and } \frac{R}{100 + d} \times d \text{ when the base} = 100 - d.$$

When d is small (say 1 or 2 yards), we may neglect it in the denomination in calculating this error, and consider it $= \frac{R}{100} \times d$ nearly.

Thus, suppose 98 yards measured for 100 in the base, and the real range to be 3000 yards, the observation would give about 60 yards too much, viz. 3060. Should the base be more than the proper length corresponding to the table, say 102 yards, then, the result of the observation would be 60 yards too little, viz. 2940. It appears to me that this method of measuring range might be employed on board ship, although, owing to my want of experience in naval gunnery, my opinion on this point is of little value. Suppose, however, an imaginary base line of 50 yards or more, according to the size of the vessel, to traverse the deck from stem to stern parallel to the keel. A telescope, centered in a vertical plane perpendicular to this base line, is mounted over the end nearest the stern. When the range is to be taken, the ship is brought round, either by her screws or rudder, until the object to be fired at can be seen through the telescope. At this moment the base line will be at right-angles to the range, and a signal from the officer at the telescope to one at the other extremity of this line gives the time for the latter taking the angle (by quadrant or sextant*), which being read off, and referred to a table calculated to the base line of the ship, the range is obtained with more or less accuracy according to circumstances.

Tables of this kind might be rendered more complete by the addi-

* Or this may be done by means of a telescope, mounted in a similar manner to that at the stern (both being furnished with cross wires), the former having, however, in addition to its motion in a vertical plane, one also round an upright axis, like a theodolite; its position with regard to the base line being indicated by the degrees and minutes on an arc in a plane parallel to the deck.

tion of extra columns showing the elevations for the guns, and length of time fuze due to each range.

Doubtless there are cases on land where the range could not be found in the manner I have described, owing to the impossibility of obtaining a sufficient length of base for all directions of fire. In some such cases other means are practicable. The range from a fort on a hill overlooking the sea, for instance, is easily estimated by the *dip* or angle of depression of a theodolite. This angle read off on the vertical circle of the instrument, and the known height of the telescope above the water, furnish data for the construction of range tables, in using which, however, a correction for the height of tide must be applied, similar in *principle* to that shown (page 434) for an error in measuring the base.

Again, where a fort covers a small island or has its front washed by the sea, a base of 100 yards may generally be obtained, weather, &c., permitting, by sending out a boat attached to a rope of this length,—the observation being taken on shore where the other end of the rope is fixed.

Measuring the vertical angle subtended by a distant object and from it deducing the range is a common plan, but it has several drawbacks, the height of the object is usually only *supposed*, and in the case of a ship she may have a *heel* which will falsify your result, even supposing you to know the exact height of her truck above water. The variation, in the angle too, is so slight compared to that in the range, that no sort of accuracy can be expected in long ranges.

In conclusion I would suggest the applicability of the table (page 433) for other purposes than those of gunnery, such as measuring the breadth of rivers, and in taking rough military surveys.

PROPOSAL FOR THE ESTABLISHMENT OF SANITARY OFFICERS IN POPULOUS DISTRICTS, WITH THE VIEW OF IMPROVING THE STANDARD OF PUBLIC HEALTH, AND AMELIORATING THE CONDITION OF THE ARMY MEDICAL DEPARTMENT.

Contributed by R. Domenichetti, Esq., M.D., Surgeon, 75th Regt.

In the present day no fact has been so generally recognised as the improvement of the public health by attention to the principles of sanitary reform, whether we regard the condition of the Army and Navy, or the civil population of this country. It is not my intention to consider how this has been brought about, but merely to advert to it as an accomplished fact, the details of which may be seen in the elaborate statistical reports of the Registrar-General.

With the view of enforcing these principles, and applying them

more closely to the requirements of the country, I venture to offer these suggestions, because it is apparent that they have hitherto been only partially carried out in large communities, and as yet the rural districts of the kingdom, where a high standard of health should prevail, are now frequently the scene of much suffering and mortality, through the prevalence of fevers, &c., which have been aptly classed amongst the preventible diseases. It is well known that these evils have arisen through want of sanitary precautions, from the absence of any organization to enforce cleanliness; and from want of attention to drainage, &c. It is obvious that medical men who derive their incomes from the population by which they are surrounded, naturally feel reluctance in bringing to the notice of the authorities what they may deem obnoxious to the public health, because such a course would bring obloquy upon them, and injure their professional interests. It may be urged that there are local authorities invested with powers under the "Public Nuisances Act," whose province it is to suppress these irregularities, but I maintain that it is essential to have the superintendence of these functionaries carried out by well-educated professional men, whose attention has been directed to the subject, and who have made it their study.

With this view I propose to employ half-pay medical officers of the Army and Navy to carry out throughout the empire the principles of sanitary reform, and few would be inclined to cavil at this arrangement, for such a course would relieve the Government at this juncture of a great source of embarrassment, in connection with the medical department of the army more especially.

By granting an optional retirement after 21 years' service to medical officers on a liberal scale, and appointing them to posts in the sanitary commission, an additional source of income would thus be opened to them in the shape of an allowance for house rent and travelling expenses; and the medical service, now so depressed by slow promotion, would be resuscitated, so to speak, without any great drain upon the Imperial Exchequer, for numbers of medical officers would gladly accept these appointments when entitled to them through length of service, for the sake of the advantages which they would offer as permanent posts.

I could dilate at length upon the utility of this scheme in at once diminishing the death rate of the districts where this system was enforced, for thousands of instances might be adduced where attention to sanitary precautions might have saved the lives of many members of a family whose deaths have been owing to some glaring violation of sanitary principles. This must be conceded by all who have paid any attention to the subject, and we have proofs that the system, as now carried out in the army both at home and abroad, although attended with some outlay at first, has resulted in the saving of a vast number of lives and money to the state. The country owes a debt of gratitude to the late Lord Herbert and the present Secretary of State for War, Earl de Grey, for their labours, and the influence they have exerted in carrying out these beneficial designs in regard to the army, and I predict that before many years have elapsed, the principles of

sanitary reform will have been applied equally to the civil population of the country. Moreover, the difficulty of obtaining candidates for the medical department of the army arises from the certainty of slow promotion for the junior grades; but by adopting this expedient, a double object would be obtained, without conceding too much to the clamour which has been raised against the authorities for an evil which has arisen from circumstances beyond control. Moreover, I have to urge this more strongly because a belief is entertained that measures are about to be taken by Government for the diminution of a certain class of diseases which have seriously impaired the efficiency of the Army and Navy, and I am sure it will occur to those whose province it is to devise means of reform, what valuable aid may be given by the establishment of a sanitary commission such as I have proposed.

---

*PROPOSALS FOR THE FORMATION OF A CORPS OF MARKSMEN FOR IMMEDIATE SERVICE ON THE FRONTIER (INDIA).

By Captain J. C. Cox (late Instructor of Musketry), 1st Battalion, 20th Regiment, Camp Boolundshahr, near Meerut, November 30th, 1863.

Introductory Remarks.

At this season of the year a large number of soldiers, whose period of service (10 years) has expired, annually leave their regiments, principally for the purpose of returning to England, to see their friends, families, &c. For the most part these men are totally regardless of the advantages they lose by leaving this country, viz., 1st—The large bounty which, together with compensation money, &c., amounts to upwards of 140 rupees. 2nd—The loss of five years' service deducted from their first period of service, if they re-enlist within six months after arrival in England. 3rd—The total loss of reckoning their first period of service if they re-enlist after that time, which it is computed that about seven-tenths of them do.

After ten years' service a soldier may be considered to have arrived at a perfect state of proficiency in his profession, and, therefore, it should be a matter of the highest importance to endeavour to induce these men to re-enlist before leaving India.

For this purpose it is deemed advisable that a further inducement should be held out to the men to re-enlist, by introducing a "recruiting system" somewhat similar in its principles to the one in vogue in England, that is, giving a small sum, say, —— rupees in lieu of the

* On account of the value of these proposals for general frontier service, it has been thought desirable to give them publicity in the Journal of the Institution.—Ed.

more closely to the requirements of the country, I venture to offer these suggestions, because it is apparent that they have hitherto been only partially carried out in large communities, and as yet the rural districts of the kingdom, where a high standard of health should prevail, are now frequently the scene of much suffering and mortality, through the prevalence of fevers, &c., which have been aptly classed amongst the preventible diseases. It is well known that these evils have arisen through want of sanitary precautions, from the absence of any organization to enforce cleanliness; and from want of attention to drainage, &c. It is obvious that medical men who derive their incomes from the population by which they are surrounded, naturally feel reluctance in bringing to the notice of the authorities what they may deem obnoxious to the public health, because such a course would bring obloquy upon them, and injure their professional interests. It may be urged that there are local authorities invested with powers under the "Public Nuisances Act," whose province it is to suppress these irregularities, but I maintain that it is essential to have the superintendence of these functionaries carried out by well-educated professional men, whose attention has been directed to the subject, and who have made it their study.

With this view I propose to employ half-pay medical officers of the Army and Navy to carry out throughout the empire the principles of sanitary reform, and few would be inclined to cavil at this arrangement, for such a course would relieve the Government at this juncture of a great source of embarrassment, in connection with the medical department of the army more especially.

By granting an optional retirement after 21 years' service to medical officers on a liberal scale, and appointing them to posts in the sanitary commission, an additional source of income would thus be opened to them in the shape of an allowance for house rent and travelling expenses; and the medical service, now so depressed by slow promotion, would be resuscitated, so to speak, without any great drain upon the Imperial Exchequer, for numbers of medical officers would gladly accept these appointments when entitled to them through length of service, for the sake of the advantages which they would offer as permanent posts.

I could dilate at length upon the utility of this scheme in at once diminishing the death rate of the districts where this system was enforced, for thousands of instances might be adduced where attention to sanitary precautions might have saved the lives of many members of a family whose deaths have been owing to some glaring violation of sanitary principles. This must be conceded by all who have paid any attention to the subject, and we have proofs that the system, as now [illegible] out in the army both at home and abroad, although at[illegible] s[illegible] lay at first, has resulted in the saving of a vast n[illegible] ey to the state. The country owes a debt of [illegible] Herbert and the present Secretary of State [illegible] r their labours, and the influence they have [illegible] beneficial designs in regard to the army, [illegible] ears have elapsed, the principles of

thirty shillings paid for the bringing of a recruit at home to the man who re-enlists him.

Many good soldiers will not re-engage at the head-quarters of their Corps, for private, and sometimes regimental reasons; and were "recruiting depôts" established on the above principle at the three Presidencies, it is believed that many of them would re-engage in other corps, and that thus an enormous expense would be annually saved to the Indian Government; as the cost of replacing a soldier at the head-quarters of a regiment is estimated to be upwards of 200*l.* This year in particular a great number of smart well-trained soldiers are claiming their discharge, amongst whom is a large proportion of "marksmen;" these men properly equipped and led would be invaluable on the frontier at the present crisis. The formation of a Corps of marksmen thus constituted, would be a saving of a great expense to Government, and would (if such a Corps be required) avoid the necessity of applying to regiments for volunteer marksmen.

Formation of Corps of Marksmen.

It is proposed, should it be deemed advisable, that the Corps should be constituted as follows:—

1 Captain, Commandant.
1 Lieutenant, Second in Command.
1 Lieutenant, Adjutant and Quartermaster.
3 Subaltern Officers doing duty.
1 Medical Officer, and Staff of Apothecaries.
1 Serjeant-Major.
1 Musketry Instructor Serjeant.
1 Quartermaster Serjeant.
1 Orderly Room and Paymaster's Clerk.
1 Armourer Serjeant.
1 Bugle Major.
6 Serjeants.
12 Buglers.
120 Rank and File.

Further, that the whole of the officers shall be in possession of a first-class certificate from the School of Musketry at Hythe, or Fleetwood, in order that they may thoroughly understand the value of the weapons with which it is proposed to arm this Corps, and that every non-commissioned officer and private must have qualified himself as a marksman during the last annual course of musketry instruction, and be in possession of at least one good-conduct badge, and also be in a good state of health, of athletic frame, and capable of undergoing those peculiar hardships to which, from the nature of the duties he will have to perform, he must at times be exposed.

Enlistment.

That the men of the above Corps should be re-enlisted for 10 years' general service, so that in case of any misconduct, the Commandant,

with the sanction of his Excellency the Commander-in-Chief, may have the power of removing any man to his former, or any other Corps serving in the country. It is to be hoped that the above stipulation will be of much use in making the men steady and trustworthy.

Pay and Allowances.

In order that the best men may be induced to enter the Corps, it is proposed that an allowance be granted, in addition to the pay at present given to infantry regiments, on the following scale per diem each :—

	Rupees.
1 Serjeant Major	2 0
1 Musketry Instructor Serjeant	
1 Quartermaster Serjeant	
1 Orderly Room and Paymaster's Clerk ..	
1 Armourer Serjeant..	1 8
1 Bugle Major	
6 Serjeants	1 0
6 Corporals	0 12
12 Buglers	0 8
114 privates	0 8

The staff pay of officers to be left as a matter for future consideration.

Dress.

As the great object of a marksman is to be as invisible to his enemy as possible, and as it has been proved, by experience, that a light drab colour is best suited for this purpose, it is recommended that this colour be adopted, and that the whole of the equipments and clothing be assimilated in shade as much as possible.

Coat—a loose tunic of thick pushmeena or puttoo.

Breeches—of corduroy, with continuations of cloth.

Gaiters—from the knee, of leather or canvas, fastened by running loops.

Caps—for full dress in hot climates a turban; for undress and in temperate climates a forage cap, without peak, surrounded with a band of mohair lace, with cross rifles and crown in front.

Boots—laced up in front; or, for the hills, sandals.

Great Coat—of the same material as tunic, warmly lined, to be worn rolled over the right shoulder, and rifle case; the ends to be strapped together under the left elbow.

Moreover that each man be provided with three warm flannel shirts, in addition to the kit with which he is already provided.

That the officers' dress be precisely the same as that of the men, with the exception of the usual stars and crown on the collars, which are to be of a drab material.

Equipments.

Rifle.—Rifled on Lancaster's principle, with improved twist, bore 557, length of barrel 2 feet 9 inches, breech-loading, sights attached

for 1,000 yards; also telescopic sight, with lens for use at night; to have a sling of drab colour, and to be fitted with ramrod and self-capping apparatus. N. B.—As this rifle will be exactly of the same bore as those at present in use in the army (should the breech-loading ammunition run short), it can be used as a muzzle-loader with the ordinary ammunition, and as it will take some time to procure the rifles from England, the Corps may, in the meantime, be equipped with the ordinary Enfield rifle.

Bayonet.—Sword pattern, as used in rifle regiments.

Belts, &c.—The rifle, with cleaning apparatus, &c., be enclosed in a leather case, and to be fastened on the back, muzzle upwards, by a belt passing over the left shoulder and under the right elbow, and buckled in front. The bayonet to be fastened round the waist by a similar belt: the fastening of this belt to be a snake buckle.

A Ball Bag for loose ammunition, capable of holding twenty rounds, to be worn on the right side, attached to bayonet belt by straps, and pouch capable of containing forty rounds, and attached to bayonet belt by sliding straps, to be worn on the left side, in front or at the back, at the option of the wearer. A bag for caps, with which to supply self-capping apparatus, to be fixed on the cross-belt for supporting rifle, a little below the buckle.

Officers' Equipments.—Sword, sling-belt, with leather scabbard, a ball bag to be carried on the sword-belt in front, on the left side. On the right side, in front, fastened to the sword-belt, a pair of powerful binoculars in case.

A revolving rifle, sighted to 500 yards, to be carried on the back in case, as by the men, with belt, buckle, cap-pocket, &c.

N.B.—The whole of the pouches and cap-pockets should, if possible, be made perfectly water-tight, and the belts, pouches, rifle-cases, &c., should, as nearly as possible, assimilate to the drab colour of the dress. Should the officers require it, they could carry extra ammunition in a pouch fastened to the sword-belt behind, as the men.

The Corps to be Mounted.

As such a Corps as the above would be exposed to great hardships from forced marches, &c., and as much of their efficiency would depend on the celerity of their movement, it is proposed that each man be mounted on a sure-footed hill-pony, between 13 and 14 hands high. Equipped with an ordinary hunting saddle and bridle, a blanket to be strapped in front of saddle, and a leather case, containing compartments for water-bottle and cooked provisions, behind. It will be observed that in dressing and equipping the "marksmen," care has been taken to make the dress suitable for riding, as well as serviceable on foot, and that both hands have been left free for the management of a horse, if required. The rifle is also so placed as to be least liable to be injured in case the soldier should be thrown, which may be expected frequently to happen on the first formation of the Corps. The syces should be dressed in warm suits of the same colour as the soldiers.

Camp Equipage, Carriage, &c.

As it is necessary that the baggage of this Corps should be as light as possible, no soldier should, on any account, be permitted to carry more than 12 seers' weight of baggage, and an officer only 24 when on service (including cooking utensils, and servant's traps, &c.). Tents to be of the Chodaree pattern, and capable of being carried by two coolies, each to accommodate seven men. In districts where ponies are not available for use, it is proposed that the baggage, ammunition, forage, &c,, be carried on mules, and when in very hilly districts, by coolies.

Further Suggestions.

In order to render this "Picked Corps" still more popular in the army, it is proposed that, during the time of year it is not required on service, it be located in a small settlement for itself, in a salubrious climate, not far from one of the sanataria; that cottages be there erected, capable of containing two, three, or four soldiers, at their own option.

That workshops be built, where trades, principally of a fancy character, such as photography, printing, book-binding, fancy painting, gilding, &c., may be carried on. That a large garden and farm be established for the purpose of rearing and fattening an improved breed of cattle, pigs, and poultry of all sorts, and of supplying vegetables, fresh eggs, and butter. The produce of such workshops and of such a farm and garden would find a ready market in such a sanatarium as Simla. In order to improve, in an educational point, the position of the men, it is proposed that a schoolmaster be appointed to the Corps, who is capable of imparting instruction in mathematics, history, geography, drawing, &c., &c. It is considered advisable that this schoolmaster should have passed in Hindostanee, as it is a well-known fact that one European can attain a proficiency in the language from another more easily than from a native, especially if the learner be a man of poor educational attainments. Such a schoolmaster would, moreover, be qualified to act as interpreter, and even as paymaster to the Corps, should his services be required. A staff salary of 150 rs. is recommended to be given for this purpose. In order, as much as possible, to improve the moral and physical condition of the men, it would be advisable to encourage *marriage* amongst them, in a much greater proportion than that now allowed to other regiments, and that every facility be afforded to the married men of making themselves and families comfortable in the proposed settlement; but at the same time care must be taken to impress on their minds that marriage must be no impediment to the fulfilment of those active duties they may be called upon to perform at a moment's notice. As regards the workshops, farm, and garden, &c., it is proposed that at the end of every month the profits of each trade, &c., be ascertained for the current month, and that, in proportion to the profits, the men who work, be paid liberally for each hour's labour; but that it be distinctly understood that money accruing from the extra pay of the Corps, or

from such labour, be not allowed to be used for the purpose of purchasing the men's discharges, but that a savings' fund be established, in which the men may lay by their money, and that when a soldier has laid by a sufficient sum, he may be allowed to invest this sum in any scheme he may think proper, such as railway shares, tea plantations, &c., or that he may invest it in his own name in one of the Indian banks, for which, as a permanent deposit, he will receive the usual percentage as interest.

Concluding Remarks.

Although the equipments will be rather an expensive outlay, it is considered that such outlay will be soon covered, by the saving to Government the cost of replacing the discharged men by recruits in their regiments, and also by having immediately at hand a picked body of men, combining the advantages of efficient riflemen with the celerity of the cavalry soldier. Could this Corps be brought to the state of efficiency of which it is capable, no troops in the world, of equal numbers, could stand against them. They would possess the precision of the Voltigeur with the ubiquity of the Cossack. Should a sufficient number of marksmen not be attainable from the time-expired men, it is proposed that two or three volunteers be procured from each regiment in the Presidency, in order to complete the required number.

Should this scheme turn out a successful one, it would perhaps be advisable to increase the number of the Corps; but this matter is left as a subject for further consideration.

It is further suggested that the soldiers of this Corps, on being discharged at the expiration of their service, shall either be permitted to retain their cottages in the settlement, or, if they prefer it, a small grant of land may be given to them in any other part of the Presidency, on condition that they settle on it personally, and are liable for military service, if called on, and be paid for performing the same. By this simple expedient a certain number of military settlers may be obtained.

Monday, May 16th, 1864.

Captain LEOPOLD G. HEATH, R.N., C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 2nd and 16th of May, 1864.

LIFE.

TAYLOR, C. S. S., Lieut., Royal Horse Artillery, £9.

ANNUAL.

Plummer, H., Capt., 7th Royal Fus., 1*l.*
Barker, J. B., Capt., 75th Regiment, 1*l.*
Paley, R. S., Capt., 12th Royal Lancers.
Le Queme, J. C., Capt., 12th Royal Lancers.
Gower, E., Capt., 12th Royal Lancers.
Cox, A. C. W., Cornet, 12th Royal Lancers.
Spragge, F. P., Lieut., R.E., Bengal, 1*l.*
Evelyn, C. F., Capt., 3rd Royal Surrey Militia, 1*l.*
Dakyn, J. H., Surg., late St. Kit's Militia, 1*l.*
Hall, W. King, Capt., R.N., 1*l.*
Sim, C. E., Capt., R.E., 1*l.*
Pilleau, H. G., Lieut., R.E., 1*l.*
Blood, B., Lieut., R.E., 1*l.*
Chichester, H. A., Capt., 81st Regt., 1*l.*
Miller, T. C., Ensign, 59th Regt., 1*l.*
Burke, H. P., Capt., 91st Highldrs., 1*l.*
Daubeny, W. A., Lieut., 3rd Buffs, 1*l.*

PROGRESS OF ORDNANCE ABROAD COMPARED WITH THAT AT HOME.

By Commander R. A. E. Scott, R.N.

In my lectures in April and May, 1861,* I gave an account of the various systems of rifling in this country, and showed the advantages and defects of the plans of Mr. Lancaster and Mr. Haddan for firing iron shot, and of Mr. Jeffrey's and Mr. Britten for firing lead-coated projectiles.

I showed that neither of the two former were well adapted to round ball firing, Mr. Lancaster's rifling giving the round shot an increasing spiral motion instead of spinning it round its axis, and Mr. Haddan's rifling cutting away too much of the surface of the bore.

I also pointed out that the elongated projectiles of both these rifled guns pressed outwards against the bore with a violent thrust, which, in shell firing, especially from the Lancaster gun, was liable to cause

* See Journal, Vol. V, p. 423, et seq.—Ed.

the fracture of the shells, as happened in the competition trials of 1861; but I omitted to point out, that Mr. Haddan's larger projectiles were proposed to be made with two bearings, put on in line with their long axis, (Plate XXXIII. fig. 1):—* Mr. Haddan was, I believe, the first to fire a large cannon projectile, tapered at the rear (Fig. 2), but Mr. Woolcombe, of Plymouth, was the first to show clearly the advantage in range attainable by this form.

Of the lead-coating plans I showed that, from the lead being driven out at the base of the shot, the shot's point, having no support to keep it up in the centre of the bore, it must of necessity drop; also that lead would not withstand the large charges of powder necessary to pierce armour plates, and that such shot were extremely liable to accidental injury, in carriage, handling, and storage on board ship.

With reference to the coil guns, as then constructed, I pointed out their liability to open, from the numerous small pieces of which they were constructed, and from these not being hooked together; and of the liability of their inner tubes, to show flaws; and I predicted the failure of such delicate weapons in actual warfare. After adverting to the evils arising from the use of lead-coated shot, and showing the great strain thrown upon the gun in the compression system, to the danger of the breech apparatus, the serious fact that the breech-loader, from this weakness, was as unsuited for chase as for broadside guns, was pointed out: in short, I endeavoured to make it clear, that the requisites for good naval guns were not complied with, either in the systems proposed for adoption by the inventors I have named, or in those guns actually adopted into the service.

In my lecture this evening, I propose going through the modifications since then introduced into our own, as well as into foreign artillery; and I trust I shall be excused if here and there I appear too anxious, in the comparisons I shall have to institute, to show that, in what I foresaw and foretold, I have been correct. Unless I had been correct in some of my conclusions as to results, I should have little excuse for again trespassing on your time and attention. And I further hope, in my concluding remarks, to touch upon some of the points in connection with the vessels which are to carry and withstand the ordnance I shall have to describe.

There is nothing like ventilating these questions in a country so full of inventive genius and mechanical ability as our own, and I believe it is owing to the course pursued by the Iron Plate Committee, presided over by that accomplished sailor, Sir John Hay, and numbering amongst its members Dr. Percy, of European celebrity, as well as Mr. Fairbairn, that such a vast improvement has been already made in the

* The projectiles used for the Lancaster guns in the Crimea were straight, and about the middle of 1860, the cast-iron shot for the oval rifled cast-iron 32-pounder were still straight, but covered at the rear with a wrought-iron casing, which projecting 4 inches beyond their base gave space for the insertion of wooden wedges. These were intended to force out the casing, which had two slits so as to fill the bore, but the plan was afterwards given up, and about the beginning of 1861, shot were for the first time made which were fitted to the spiral of the oval rifling.—R.A.E.S.

Fig.
Haddan's Prop

Fig. 7.
Parrott Rifling.

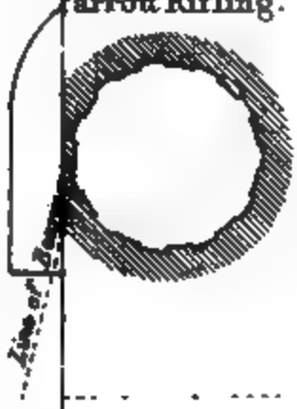
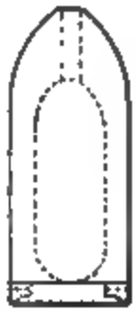


Fig 8.
Parrott Shell



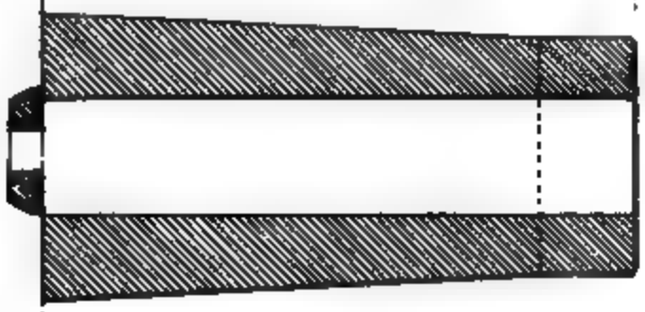
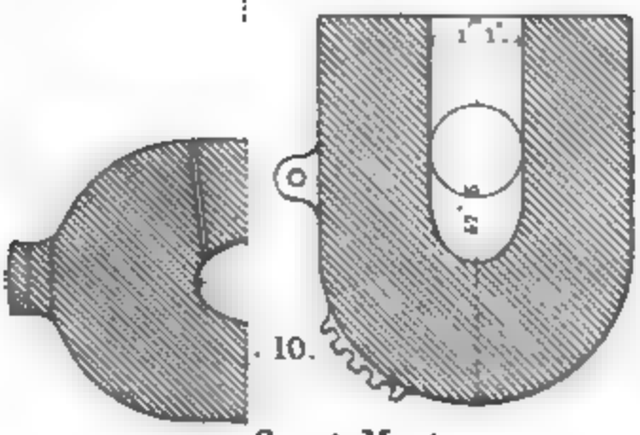


Fig 6
Parrott Gun.

Section

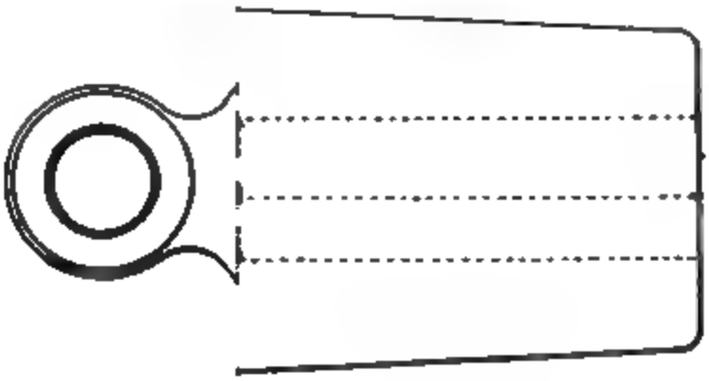


10.

Coast Mortar.

Fig. 13.
Blakely's Solid Shot.

Elevation



Plan

J.R. Jobbins

manufacture of armour plates. Their course has been to freely invite both the target contractors and the ironmasters to come forward, and when at Shoebury, to give them every information; and the result has been, that steady progress which has enabled our manufacturers to produce plates of very superior quality to those made in other countries. I cannot forbear also mentioning the name of Captain Harrison, of the Artillery, the indefatigable secretary, whose courteous behaviour and readiness to impart information has been noticed by all, and I sincerely believe that the valuable hints so readily given by Lieutenant Colonel Henderson, of the Artillery, and by all the committee, have had a considerable influence in the improvement of armour plates. In truth, the whole iron manufacture of the country seems to have received a great impulse from the tidal wave from Shoeburyness. After all, there are few, if any great inventions; it is the constant little improvement in one's own special calling or profession, and the onward progress towards a goal kept steadily in view, that comes at last to be "the great invention."

As that able mechanic, Mr. Anderson, said to me, when I took up with rifled ordnance, in the beginning of 1859, "If you wish to be successful, lay down upon paper all the requirements for a naval gun, consider each point day by day for months, and when you have decided upon what you want, and marked out your course clearly, then submit your plans." Had the course indicated by Mr. Anderson been followed by all, and the same means of knowing results as in the case of the armour plate experiments, been afforded, England's naval ordnance would not have been still in a transition state, but would have been settled upon a firm basis, and the nation would now possess an armament as immeasurably superior to that of other countries, *in proportion to cost*, as are the armour plates now manufactured by her.

It is not, however, too late to retrace the steps which have been taken, and although large sums have been expended through the concealment, hitherto adopted in respect of the coil guns; the different result obtained through the opposite course in plates, *must* for the future, ensure also a more liberal policy in the gun question; this should not be a contest between one powerful company and another, or between individuals for precedence, but a full and open trial of the principles of rival guns, after which there should be selected, without fear or favour, the most practical plan, or the best part of two or more plans, for the national armament. Had the Armstrong mode of construction in the Royal Arsenal been open to the view of the makers of guns, public would have stimulated private manufacture, and *vice versâ*, and England would be at this moment the armoury of the world, as she undoubtedly is the great iron plate maker. True it is, that the energy of our gun makers is fast breaking through all obstacles, but the difficulties interposed have greatly tended to check production, and driven at least one firm to leave the trade. The true policy of England is, to make herself the mart of the world, and by keeping the gun, shot, and armour trade in her own hands, to command the market, and thus have the benefit of production in enlarged trade, and in the superior capabilities and skill in manufacture, which

would be available for the national benefit in all times of need. This policy, alone worthy our great nation, whose favourite motto is, "a fair field and no favour," would in time of peace prevent the squandering of the national treasures, and by keeping us prepared for the time of war, enable Britain to securely maintain her seat as mistress of the seas.

Public opinion, expressed through Parliament and the press, is a great safeguard and a surer defence than dozens of fortresses; but should war overtake us, or another panic occur, a story of the ships (so armed as to be unfit for warfare) might follow "the story of the guns." It has already done so in America. Hear what the New York correspondent of the English "Army and Navy Gazette," (dated 23rd January, 1864,) says, "We are ruled in these matters by a few monied men, who back up the Ericsson interest. No one can deny the fact, that John Ericsson is a splendid engineer, and that there are but few such inventive minds in the United States; but surely that gives him no right to use his utmost endeavours to crush out all who are opposed to him; in certain official quarters his word is law, and the plain truth is, that the Swedish engineer sways a power, in reference to our iron-clad navy, a king might well be proud of. He can purchase opinions; reports can be toned to suit him; faults can, or at least have been, concealed in reference to our ships. Our people have been duped and science thwarted by this man. The reports of the commanders of the iron-clads at Charleston opened the eyes of the public, and queries are more frequent in reference to our ships than ever. It is a sad state of things to contemplate, yet, for all that I can see, we must submit for a time at least. He who favours a Monitor is in favour, but woe to him who reports against them. Look at Drayton, Warden, Rhind, and others, all suffering in a quiet way the displeasure of the department, because they did not say what they did not honestly believe."

French Guns.—In my second lecture, that "on the progress of ordnance abroad compared with that of ordnance at home," given in this theatre on the 20th January, 1862, I pointed out that the principal value of the French cast-iron guns, which had been hooped and rifled, was, that they still fired the round ball—making use of the rifle shells holding a large quantity of powder, but which were projected with a low charge—for the purposes of bombardment; and I showed that the gaining twist adopted by the French, under the impression that the weak cast-iron was relieved by the easy starting of the shot, was a mistake. To-day, I am enabled to say that I have been informed, on what I consider to be good authority, that the French are making steel guns, which they have rifled with an *even* twist upon a simple plan, giving, it is said, a long bearing to their shot. (See Fig. 3.)

Of the performance of their steel ordnance, it is said that 4·3-inch plates, with backing similar to that of the "Warrior," were pierced at 1,000 yards by steel shot from a gun weighing 6 tons.

Prior to the adoption by the French of the centrical grooving, in December, 1862, the French tried a plan (Fig. 4) on a similar principle to that of the shunt, but the buttons upon the projectiles required too

great a nicety of fitting; for, if the shot were large in their diameter, a great strain was thrown upon the gun by outward pressure at x, and if small, then there was a tendency to slip over the shoulder at y. The rifling of the French field-pieces, which are muzzle-loaders, continues to be the same, and the projectiles have similar studs to those that were first adopted by them. (Fig. 5.) This plan, which was used at Solferino and in China, was at the last place very unfavourably contrasted with the Armstrong, but now bids fair to supplant it altogether. (Studs of copper have been lately adopted in England for the projectiles fired from the shunt gun.)*

United States' Guns.—In the same lecture I gave an account of the American ordnance, and have since had opportunities of talking with officers who have taken part in the struggle going on, on the shores and on the rivers of that vast continent. They told me that for ships, their naval men have always been opposed to rifled guns, and though several of the larger Parrott's have been introduced in lieu of heavy smooth bores, it was in opposition to their opinion. One naval officer, who had commanded a squadron, said that their crews were afraid of using the large rifled guns, and that in consequence he gradually got rid of all but a few light chase pieces. Experience gained at Charleston shows that the men's fears were not without foundation, for out of all the Parrott rifles, the great proportion gave way below an average of 300 rounds a-piece.†

A few of these guns went through the re-inforce (Fig. 6), but the greater part gave way in front of it and some guns split near the muzzle, owing to the increasing twist, which, by checking the shell, caused an explosion in the bore, where the shot caught against the rifling.

This was the case in the first 300-pounder at Charleston, which had its muzzle broken after a few rounds. The premature explosion of the shells is about to be attempted to be remedied, by the introduction of a fuse similar in its properties to the fuse of Colonel Boxer.

I should mention that most of these guns were fired at very great elevations which, by preventing recoil, threw a heavy jar upon them at each discharge; they answered well on the practising grounds when fired horizontally, but could not bear the increased strain arising from being fired at high angles of elevation.

The Parrott rifling consists of several rectangular grooves, similar in form to those used by Manton in 1790, and more lately in England by Mr. Britten (Fig. 7); it has an increasing twist towards the

* The French experimented with copper studs, but found that they caused greater wear upon the rifling of their brass field-pieces than those of zinc, which they *adopted*. With the larger shot for their canon rayé of 30, zinc buttons could be readily run upon a rough cast projectile, and were very cheap; the plan was therefore also adopted by the French for the elongated shot of their cast-iron rifled guns.

† Although many of the Parrott guns burst prematurely at Charleston, 1,000 rounds were fired by a Parrott 100-pounder at West Point, and another similar gun has fired 1,400 rounds on service. A 30-pounder also has fired 3,000 rounds into Charleston at from 30° to 40° elevation; and one of the 300-pounders at Charleston has fired 600 rounds. All these guns are still in use, and are in good condition. —R.A.E.S.

muzzle, and the projectiles have a brass ring round their base (Fig. 8), which is expanded out into the grooves by the explosion of the powder. This ring is, however, liable to break without giving rotation to the shot, and it sometimes fails with heavy charges to take the rifling properly. The Parrott guns were at first cast solid and then bored out, but the contractor, who thus made them for cheapness, has now commenced to cast guns hollow, but without trunnions. These are put on afterwards. The early guns were similar in this respect. Parrott and others are now following Rodman's plan of giving no preponderance to the breech of the gun, which is kept in place by the elevating screw. This plan is found to lessen the jar upon the gun, and to preserve the carriage from injury in firing large charges.*

The Americans have now turned their attention to steel, and a firm has recently purchased the right to use the Bessemer process. Actual war, however, is a bad time to make changes in, but the Northern States have so long felt the necessity for a stronger material than cast iron for rifled guns, that they intend to commence the manufacture of mild steel immediately.

The Northern Government very early had an Armstrong gun made by workmen who left Woolwich Arsenal, which gave quite as good results as to accuracy, &c., as the weapons made in England, but on their testing it for continuous firing at high angles, to try its powers for distant bombardment, the breech first got out of order, and then gave way, which caused an abandonment of the plan. It would have been well had they tested their contract Parrott guns in a similar manner.

The 15-inch smooth bore guns, cast hollow, seem to have been a complete success, and to have given velocities of 1,300 feet with 50 lbs. of powder and a hollow shot weighing 420 lbs. (Fig. 9.) The Army gun weighs 22½ tons, and the Navy 19 tons, the usual charge for the latter being 35 lbs., and for the former 50 lbs. The American opinion still is, that to damage an armour-clad or other vessel seriously, it is not the clean, small hole-piercing property they need; "it is the smashing effect, the staving in of planking and timber; or if a hole alone is made, that it shall be so large as to defy plugging." So confident are the Americans of the truth of this, that their forts are either armed, or fast being armed, with 22½-ton guns of 15-inch bore, which will fire hollow shot, and also shells having a large capacity for powder or molten iron. Their effect may in some measure be imagined from the fact that the shell fired from our own "Big Will," the 600-pounder of 13·3 inches bore, entirely smashed the floating "Warrior" target, moored 1,000 yards from the shore, at the low velocity of little more than 1,000 feet per second.

Captain Fishbourne has already told you of the new cast-iron 10-inch American gun, of 7¾ tons, throwing a nearly solid shot of 125 lbs., and a shell of 100 lbs., and intended to fire a customary charge of 30 lbs. of powder. This gun has, in addition, a special charge of 43 lbs. for use against iron-clads—a charge which constitutes it the most power-

* The weight of the 10-inch Parrott is between 11 and 12 tons, charge of powder 25 lbs.—R.A.E.S.

ful broadside gun belonging to any foreign nation. The 11-inch Dahlgren guns have been ordered by the Secretary of the Navy to fire a charge of 30 lbs. of powder if engaging an iron-clad; but the usual charge is, 20 lbs. for a solid shot, and 15 lbs. for a shell.

The charge of 30 lbs. was adopted, after considerable trial when it was found that these 11-inch charcoal iron guns were far stronger than anticipated, and that, as an iron-clad would be engaged at close quarters, and the gun then be laid nearly horizontal, it would have a comparatively small strain thrown upon it.

In the Northern States of America great attention has been paid to the subject of gun carriages, and as the improvements have been suggested by those who have to use the guns, the arrangements for working the guns are exceedingly simple, and the carriages strong, and little liable to get out of order. Their naval gun carriages are in advance of those of any other nation, and they are now about to use iron for their construction.

In their mortars the Americans have adopted as the best plan, that of placing the trunnions at the re-inforce (Fig 10), a plan pointed out in this Institution, which has been found to prevent that splitting in halves in consequence of the wrong position of the trunnions which took place at our own bombardment of Sweabourg. It is a curious coincidence that the solid cast English mortars at Sweabourg, and the solid cast but strengthened Parrott rifled guns, which were likewise fired at high elevations at Charleston, showed about equal endurance.

By placing the trunnions at the re-inforce the mortars can be brought to the horizontal position with comparative facility, and hence used as howitzers for horizontal firing. This property so impressed the Secretary of the Northern States' Navy, that a squadron of mortar-boats was sent to the Mississippi, but the mortars were unhandy, and the damage produced was so trifling, from the inaccuracy of their fire, that they were soon landed.

The Confederate Guns.—The South, although unaccustomed to the founding and manufacture of iron, soon started a foundry for ordnance, and have since continued to turn out cast-iron guns in considerable numbers. The size of bore most in favour for their defences is 10 inches, and it was round steel shot from those 10-inch smooth bore guns which did them such good service at Charleston. Large numbers of their steel shot are said to have been made in this country, and were, I imagine, sent out as *cheeses*, during the time of the supposed famine. It was, I imagine, through pure philanthropy and nothing else, that the sides of the Northern Monitors were pierced.

The Southerners have also their pet rifled gun, which, like the Parrott, is of cast-iron, strengthened with a band over the breech, it is called after Captain Brooke (see Fig. 11), but they found from the capture of their vaunted "Atalanta," intended to destroy the Northern gun-boats in *detail* by firing at long range, that they were egregiously deceived in the power of their rifle, and that their smooth bore was their best gun. The rude means of dispelling their confidence was a 420 lb. shot from the "Weehaken's" Rodman

gun, which shook every timber of the "Atalanta," killing and wounding about 20 men, and paralysing the remainder of her crew. The shock must have been terrific, and from a computation made as to its velocity, it has been estimated that the force of the blow was about equal to that delivered on the "Warrior" target by the 282 lb. shot from the Horsfall gun (Fig. 12), which, when fired from a distance of 800 yards, struck with a velocity of 1,282 feet per second.

The Southerners have received a considerable number of field guns from Europe, and some strengthened cast-iron guns of large bore; and I believe shot of form like Fig. 13 were fired at Charleston. It is said that they have had some built-up steel guns sent them lately. Fig. 14 (Plate XXXIV) represents the pattern of two or three guns which were some time since made at Low Moor, of the 65 cwt. 8-inch pattern, but only bored to 7½ inches, which were then strengthened by steel hoops; but very few of us have now any faith in cast-iron as a fit material for rifled guns. Fig. 15 shows the wrought-iron gun made for the Northerners in 1845 by the Mersey Company, to replace the gun which caused such serious loss of life by bursting on board the United States' frigate, "Princeton." It was proved in England with the following charges, which are very heavy for a gun weighing only 7 tons:—

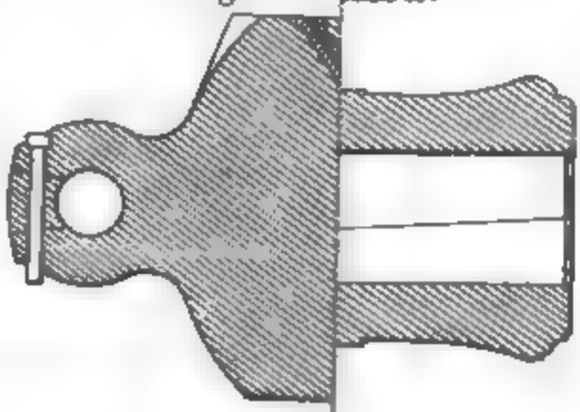
1st charge of powder, 30lbs., with a wad and shot weighing—
2nd to 4th, 3 charges of powder, each of 44lbs., with double wad and shot.
5th to 30th, 26 charges of powder, each of 30lbs., with wad and shot.
Total, 30 charges.

	ft.	in.
Length from breech ring to muzzle	14	0½
Do. from breech to muzzle	13	0
Do. of bore	12	0
Thickness of metal at breech	0	7¾
Do. do. at muzzle	0	3½
Diameter of bore	0	12

The Prussian system, from which our own lead-coating and breech-loading is a delicate off-shoot, consists of a rifling similar to the Parrott and Manton, with the exception that the grooves instead of being equal in width throughout, narrow towards the muzzle, which I omitted to mention in my former lecture. The object of this is to keep squeezing the lead together, and thus hold the shot up, so that its long axis may continue to coincide with the axis of the piece during its passage through the bore, for as the shot moves onward, the lead coating on its bearings necessarily becomes worn down, and hence the projectile would drop to the bottom of the bore did not this narrowing of the grooves towards the muzzle of the gun, by squeezing the lead together laterally, have a tendency to keep up the shot. It is possible that this ingenious arrangement, which certainly has the merit of not overstraining the gun, suggested the contrivance of the muzzle-nips for the English finely-grooved and shunt guns, as well as suggested the French plan (Fig. 4), the principle being similar and like that of our own early Enfields.

The Prussian projectiles are leaded so as to show raised projections

Fig. 14. ...fled.



7½ Gun and Shell.
Transverse Sections

Longitudinal Sections.

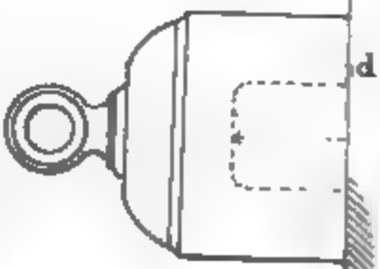
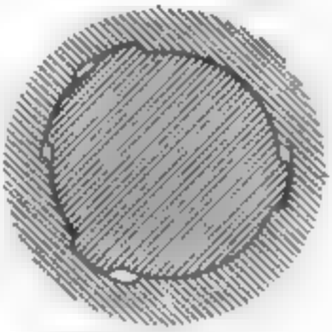
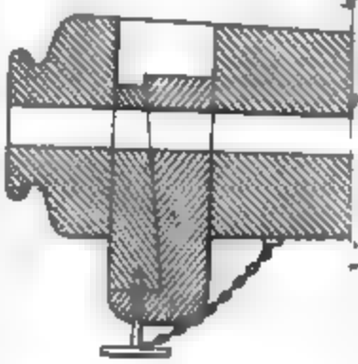


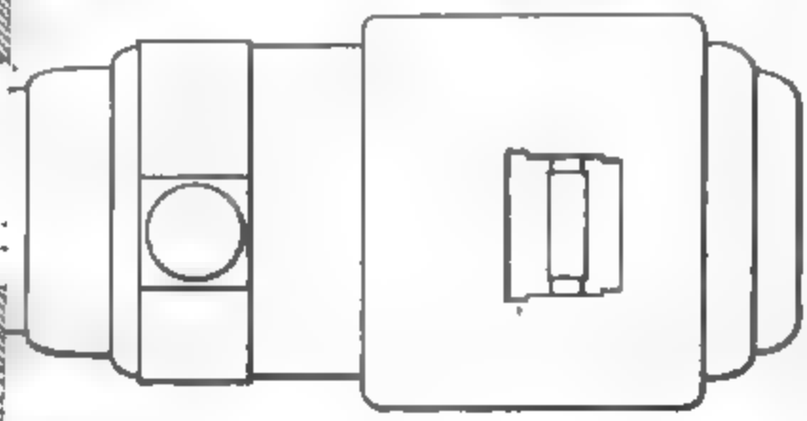
Fig 20
...d Gun Cotton Gun.



Shot coming out of Gun.

Fig. 21.
Russian Shunt Rifling.





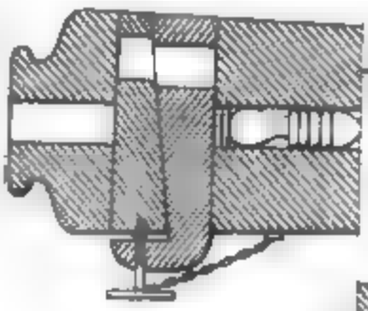
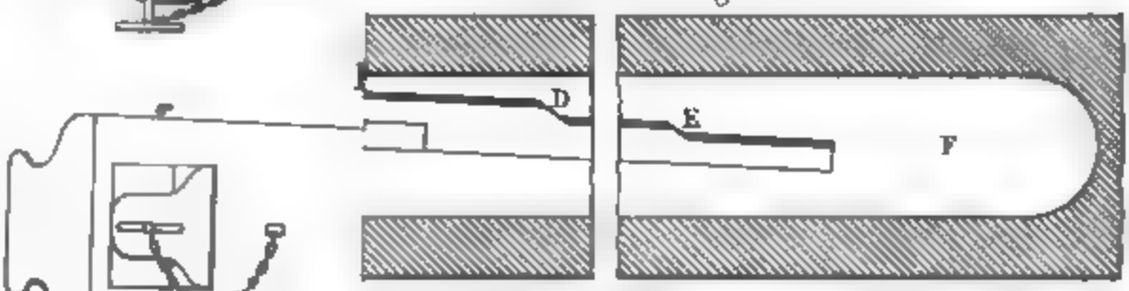


Fig. 24.
Groove (Armstrong)
Section through A B.



Reference.

Loading Side	D. *Shunt*
Drawing D.°	E. *2nd Shunt to lock Shot*
Muzzle Grip	F. *Powder Chamber*

of lead (see Vol. V. page 428), which readily squeeze down into the rifling, and hence throw comparatively small strain upon the gun. The Prussian early plan of breech-loading was with one wedge, they then used two wedges (Figs. 16, 17, and 18), but they have not found breech-loading to be so satisfactory as they anticipated, for their guns of the 24-pounder bore and throwing projectiles of 56 lbs. The Prussians commenced the adoption of rifled guns by having field-pieces, made by Krüpp, of mild steel, and the wear of these guns has given them no reason to regret their choice of the metal.* Besides these weapons the Prussians have converted many of their brass guns (remelting several) into rifled breech-loaders, on the wedge plan. The 24-pounder guns of between 50 and 60 cwt., which they were casting and rifling when I read my last paper, are now out of favour, and they are replacing these and their old cast-iron rifles with steel guns. It appears to have been a shot from one of the steel 24-pounders that lately did such damage by piercing the upper deck of the Danish cupola ship "Rolfe Kraake."

The *Austrians*, after numerous experiments with gun-cotton, and *almost* perfecting the use of that manufactured under the direction of General Lenk, seem to be unwilling to incur further expense. They have made little progress since my last notice of their artillery. The rifling of their guns, used for gun-cotton, is shown in Figs. 19 and 20. The peculiarity of this rifling is, that the projectile is given stability to, by tightening itself in a curve of gradually lessening radius, and that the grooves prevent an extreme of wedging action at high velocities; they also give facility of loading.

The position of the *Spanish*, *Swedish*, *Danish*, and *Italian* artillery is much as when I described them in January, 1862.

The Russians have been recently making numerous experiments; they have copied the French button plan, and in some of their solid steel guns have tried a rifling like Fig. 21, and also used a grooving like that in Fig. 3; they have likewise experimented with the rounded form of groove. A very large number of steel shot has been supplied to them from England; and it is understood that most of the 9-inch and 11-inch built-up steel guns, of from 15 to 22½ tons, now making by the Blakeley Company, are for this nation. The Russians have, however, given large orders to Krüpp for *solid* steel guns, and have likewise manufactured several cast steel guns from their own iron, which is of excellent quality, but the large charges and heavy elongated shot used have prevented the heavy solid steel guns, which have been as yet rifled, from withstanding 100 consecutive discharges.† This failure might, I think, be easily cured altogether, but certainly be lessened by the use of lighter shot. But there can be no doubt that the guns are powerful, and will, behind the thick slabs of iron with which their forts are to be covered, prove formidable to

* The French Emperor rejected Krupp's steel from finding, after careful experiment, that guns made of it broke up more readily than French bronze under the blows of the shot which were fired *at* them.—R.A.E.S.

† The reported premature bursting of these guns is said to be in part at least due to the character of the shunt rifling adopted.—R.A.E.S.

any ships venturing to attack them, for they can fire round shot with the heaviest charges.

Having thus briefly noticed the progress of ordnance abroad, it is time to turn to what has been doing at home, and as since September 1861, trials have been made almost exclusively with that principle of making guns and rifling them, concerning which it was declared by one in authority, that the country having adopted the system, was bound to work it out, my account must necessarily be a *résumé* of Sir William Armstrong's plans and inventions.

I have, however, the gratification of being able to state, in respect to some of the mistakes and omissions I pointed out, that although the fine grooving has not been entirely abandoned, no new 110-pounder guns are being thus rifled, and that the Armstrong 12-pounder has been reduced a foot in length, and that by the skill of Lieutenant Reeves, of the artillery, a sort of Dutch case has been adapted to the gun, for use at close quarters.

Instead, also, of the new guns being made of excessive length, the 600-pounder is so short, that it approaches the Howitzer, and the 50 Somerset guns building in the Arsenal, are, as to length and general form, all that could be desired for 6-ton naval guns.*

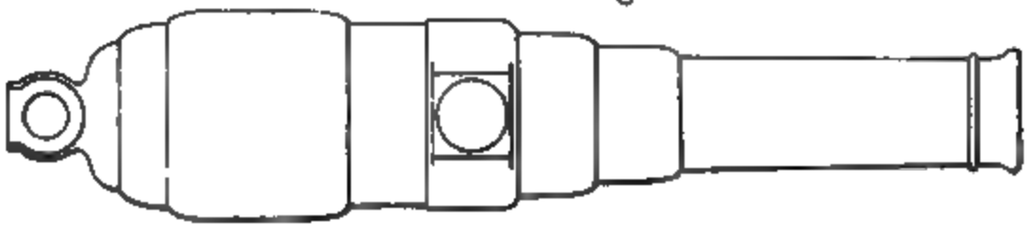
The vent-piece of the Armstrong's is also giving place to double wedges (see Fig. 22), and a vent-hole in the gun, following closely in these changes their Prussian type; in a word, breech-loading having been abandoned by Mr. Whitworth, is flickering in its socket, before being finally given up. The reputation of the shunt system, which was being introduced in 1861, is also on the wane, it having been proved that the early impressions as to the damage that would be done to the muzzle from squeezing the shot were well founded; the whole of the heavy guns rifled on this plan having cracked round or shown flaws at the muzzle, and hence it is in contemplation to give up the shunt and grips, and to come to a plain groove,† with sharp corners, similar to that advocated by Captain Palliser (Fig. 23).

I need not dwell longer upon the failure of the shunt guns, the reasons for which were so clearly pointed out by Captain Fishbourne; but as the same tendency to fracture exists in the sharp cornered groove about to be experimented with, as in the shunt groove, I may call attention to what he says as to the disadvantages of such a form, from its allowing the bearing edges of the projectile to strike the driving sides of the grooves with a force which must wear them, and ultimately cause rupture; the grooves being also liable to foul and difficult to sponge. To reduce the shock upon the shunt gun, the French field-piece button has been adopted by Sir W. Armstrong but instead of white metal, copper, which was at first tried by the French, has been taken, and this has been lately made very soft—a

* They are 9 inches diameter in the bore; the weight of their cast-iron shot is 95 lbs. and shell (which are of 1½ inch thickness) 66 lbs., windage 0·1 inch; the full powder charge is 25 lbs.—R.A.E.S.

† This rifling has been since tried and found to be deficient in accuracy, from having no principle of centring and steadying the shot in its passage through the bore of the gun.—R.A.E.S.

Fig 25
70 Pr Muzzle Loading Shunt Gun.



Armstronge

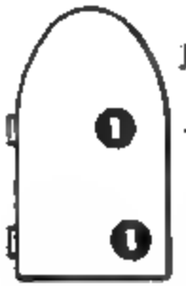
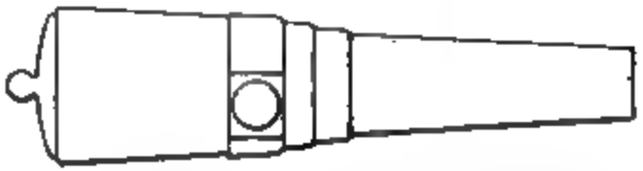


Fig. 26
12 Pr Shot

Fig. 27.
12 Pr Shell

Fig. 28.
Mackay Gun.



Elevation of Target.

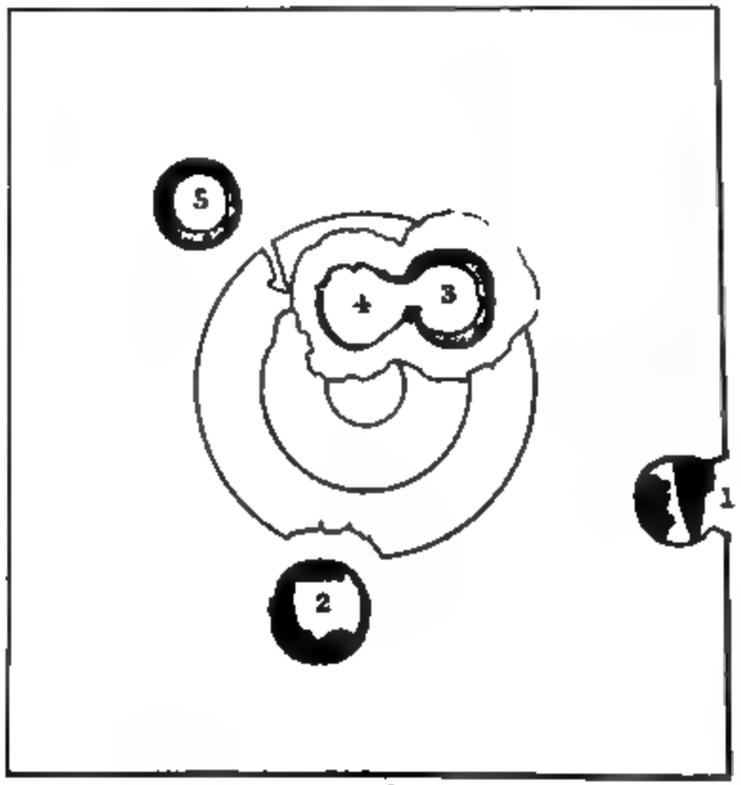
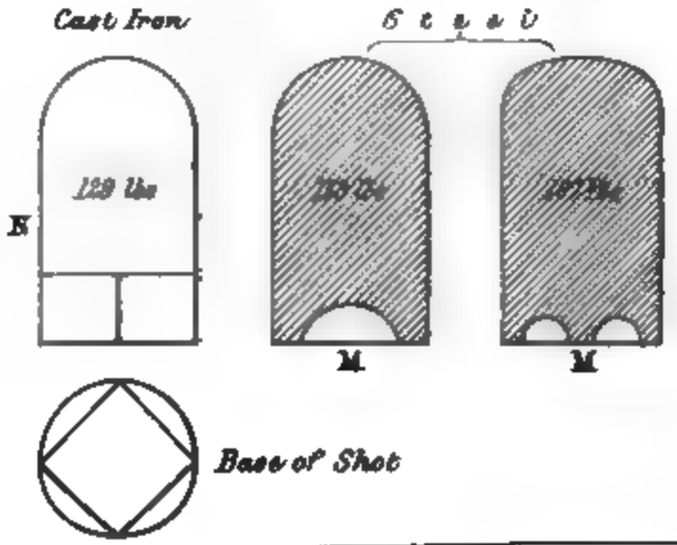


Fig. 29.

Section of Gun.

Projectiles for Mackay Gun.



Plan of Shot.

Section of Shot.

Taken through A B and C D.

quality which causes the studs to have a tendency to shear, with high charges, and get out of shape in carriage. To further lessen this shock, there is a projection upon the loading side of one of the grooves, which pushes the studs close to their bearing, when, to use the phrase derived, I believe, from Sir W. Armstrong, the shot becomes "locked," and a very tight fit it is (Fig. 24).

The Armstrong and Whitworth Competition.—It was arranged that this trial should be entirely at the public expense, and after various preliminary experiments, Sir William brought into the field three multi-groove breech-loading 12-pounders, firing lead-coated shot, and three muzzle-loading 12-pounders of the shunt pattern, rifled with three grooves and firing shot with copper buttons, the former being supposed to represent the service system, and the latter that system with which it seems to have been proposed to replace it. The Elswick Company also sent three breech-loading 70-pounders, with double wedges substituted for the usual service vent-piece and firing lead-coated shot, and three muzzle-loading 70-pounders, firing projectiles with copper studs. The weight of these latter guns is about 77 cwt., and the breech-loaders, though lighter, are heavier than the three hundred 70-pounders* (Fig. 25, Plate XXXV) made for the service. The projectiles also are different from the service pattern, and so are the shells used with the breech-loading 12-pounders.

All these 70-pounders have steel tubes, and the 12-pounders a solid steel barrel, the rear of the breech-loading 12-pounders is also larger to enable a thicker vent-piece, and a larger screw to be used, which has more threads, for the purpose of holding the vent-piece more firmly than is the case in the service gun. These guns comprise therefore Sir William's latest improvements, but do not represent any guns in the service.

Mr. Whitworth brings to the contest three 12-pounders and three 70-pounders, such as he proposes for the service. He has rounded out the angles of his rifling, and the shot, which are entirely of iron, are also rounded at the corners, a modification which appears to have improved the facility of loading, and to have lessened the wear upon the driving side of the rifling of the gun. Mr. Whitworth's competitive 70-pounders are about 78 cwt., which is a trifle more than the weight of Sir William's competitive 70-pounders.

The contest commenced with one 12-pounder of each pattern—the other 12-pounders being kept in reserve. The weight of these field pieces is:—

Armstrong breech-loader.....	8 cwt. 1 qr. 16 lbs.
,, shunt muzzle-loader....	8 cwt. 3qrs. 27 lbs.
Whitworth muzzle-loader	10 cwt.

The last gun had a vent aperture in the rear, through which it was intended to fire the charge, but there being some objection to the plan, Mr. Whitworth cleverly closed it with a plug, and uses a new vent-hole on the top, which ignites the powder charge at the centre of the cartridge.

* Since called 64-pounders.—R.A.E.S.

In diameter the bore of Mr. Whitworth's gun is smaller, and hence his projectiles have to be longer than those of Sir William's shunt gun, and their length, in order to obtain the requisite weight, has to be further increased owing to the shots being tapered at the rear. The weight of Mr. Whitworth's 12-pounder shot is 11 lbs. 9oz., and that of the shunt shot 11½ lbs. (Fig. 26). In order to contain the same quantity of powder (11 oz.), the Whitworth shell has to be lengthened to four diameters, which is rather beyond what even the sharp rifle twist of Mr. Whitworth's guns can give stability to over 800 yards; hence there is a slight loss of accuracy in firing shells from his gun as compared with those of the shunt, the shells for which are under three diameters in length (Fig. 27), and have a third button in the centre which seems to give them greater accuracy than the shunt shot which have only two.

In firing shrapnel or segment, the one invented by Colonel Boxer, and the other by Mr. Holland, which may be considered as the normal projectiles for the guns, the Whitworth had a slight superiority in range and accuracy. The initial velocity given by the guns was nearly equal, being about 1,350 feet per second, with projectiles brought to the same weight; the advantage was, however, on the side of the shunt, but the retardation of its shot being greater, the velocities were equal at 400 yards, and then the Whitworth took the lead. At 10° of elevation Whitworth's range was about 4,100 yards with shot, and the shunt about 400 yards less, indicating the flatter trajectory given by the Whitworth field-piece. On the commencement of the trial a wet sponge was used for the shunt, subsequently a dry one, but from not using a lubricating wad, the gun had to be well rubbed inside with the sponge. Still it was not loaded with the same facility as Mr. Whitworth's, for it required a tap with the rammer to send the shot home. In the quick firing of 200 rounds, Boxer's lubricator, made for the Whitworth gun, was also used for Sir William Armstrong's shunt, but the time occupied was longer, and the firing was not considered so accurate by outsiders.

The guns have now fired considerably over 1,000 rounds, and are all showing signs of wear; the lands of the shunt rifling being worn on the upper side of the bore, just where the shot lies, from the rush of gas past it, and the rival gun being very slightly rubbed by its own iron projectile; a trifling flaw or fissure also showed itself behind the vent after the 200 rounds of quick firing, but does not appear to have much increased since. It has been thought that the heating of the gun and the consequent intensity of the action of the gases from the powder being ignited at the centre of the charge, may have affected the carbon in the steel, and hence produced this flaw behind the vent. The damage to the shunt, in all probability, had its origin in the want of lubrication, which in Whitworth's gun left a coating which formed a protection against the heavy powder gases that rushed along the bore past the shot, and a rub once being established, the damage would go on increasing.

The advantage of the Whitworth system consists in the projectile being indestructible and capable of being re-fired. The wear upon

the steel bore from the iron shot is very trifling, and, probably, little if at all greater than the wear upon the shunt rifling by the copper studs, which are somewhat liable to injury. The shunt-gun has, however, the advantage of a round bore, and hence is better able to fire any other description of projectile than its own special shot.

I have not hitherto spoken of the breech-loader's performance, for the gun is so far below the standard of the other two, that even some who were the strongest supporters of the system now say, "Let us, at all events, have a muzzle-loader." And in truth they have good reason to say so; for whenever 40 or 50 rounds are fired consecutively, even with moderate quickness, the men in rear of the gun have their faces and clothes blackened by the *mild* escape of gas. It is useless indeed further to conceal the fact, that the soldiers dislike the gun as much as the sailors, and become so nervous in firing rapidly, that during the 200 rounds which were fired quickly about a fortnight since from the gun, the vent-piece was put in the wrong way, which was seen by a bystander, and once the breech-screw was not screwed up, which was also seen in time to prevent accident, by a looker on. The difficulty of working the breech-screw when fouled by the powder gases, and the water which has to be poured over the breech, to stop the heating and expansion of the gun's delicately adjusted parts and allow them to work, have been already publicly noticed. I need therefore scarcely add that the inferiority of this later improved breech-loader to the Whitworth as well as to the shunt, sufficiently justifies what has been said against breech-loading guns, and Mr. Whitworth's complaints of the hasty condemnation of his weapon.

The 70-pounders have not yet been tried, but I have no hesitation in saying that, Mr. Whitworth's projectiles having greater stability communicated by the sharper twist of his rifling will have greater penetration than the Armstrong shot, especially at distant ranges.

The breech-loader will of course be the worst; it is, in fact, 10 or 12 cwt. lighter than the other guns.

The steel shells of Sir W. Armstrong, which have been provided with thin iron caps, will not, I think, produce any very great effect, for the cap which is screwed on in front of these shells will serve as a buffer to break the blow—just as happens with his present hollow-headed shot—a form which has the disadvantage of largely increasing the deflection or drift, and of destroying the evenness of ricochet; serious drawbacks to naval use.

Captain Palliser's Strengthened Cast-iron Guns.—Captain Palliser was furnished with two 68-pounders and one 10-inch gun.* The first 68-pounder was bored out and provided with a single wrought-iron tube of about 2 inches in thickness—so as to leave the finished bore 9 instead of 8 inches in diameter. After enduring 100 rounds with

* Captain Palliser's guns were purposely passed to destruction,—in the usual manner,—to test their strength. One of Messrs. Walker's 68-pounders had previously withstood 76 discharges, which is the largest number of rounds sustained (with a single charge of powder, and iron cylinders increased by the weight of one shot after every 10 rounds) by any cast-iron English gun before being destroyed.—R.A.E.S.

16 lbs. of powder, and increasing cylinders, the gun subsequently burst at the 7th round with double charges of powder and a cylinder weighing 200 lbs.

The 10-inch gun had two tubes, and was finished with a bore of 6½ inches diameter. This gun burst at the 81st round with a powder charge of 16 lbs., and a cylinder weighing 612 lbs. The third gun had a steel tube placed inside one of wrought iron, but the steel quickly split.

The Blakely Guns. —Captain Blakely was the first to strengthen cast-iron guns, and, as Captain Palliser states, to point out the principle of equalizing the strains on concentric tubes. In 1861, two 7½-ton guns and one steel gun were rifled by me for him, and he adopted my principle of centring for iron shot. Captain Blakely also took the same form of grooving for guns firing lead-coated shot, and having, after careful trial, ascertained the greater accuracy obtained from it, he has since rifled all his guns in a similar manner.* Captain Blakely has latterly taken Messrs. Vavasseur's gun premises, and very much extended the works, which are now employed in turning out large built-up steel-guns. These have the peculiarity of being finished with massive cast-iron trunnions; † and I have only to mention that the system used by Captain Blakely is, to fire the round ball, and all the other smooth-bore ammunition, so strongly urged by Captain Fishbourne as essential for naval guns.

Having already explained to you the direction which the alterations in the French, the Whitworth, and the Armstrong guns have now taken, let me specially direct your attention to the groove I have so often and so warmly advocated in this room. You will notice that the French commenced with a gaining twist, that Sir W. Armstrong commenced with an angular groove, which could not fire either the round ball or any of the service ammunition, and Mr. Whitworth with an angular bore and sharp edges to his shot. The French some time since, adopted a groove similar to mine for centring the shot; they have now, it is reported, given up the gaining twist for the *even* twist advocated by me. The Select Committee, who have all these different systems before them, and ought, if any body does, to see the way in which things are tending, are using a groove recommended by Captain Palliser, because, as he believes, the particular angle he selects will centre the shot in the same manner as by my form of grooving which the committee have taken for the gun they intend to fire the leaded-projectiles of Mr. Britten and Mr. Jeffrey from.

I wish now to say a few words on the Armstrong 600-pounder.

This gun, with a charge of 70 lbs. of powder, has been found at 200 yards' distance to just penetrate the "Warrior" backing, covered by a 6½-inch plate; and the striking velocity of its steel bolt of 612 lbs.

* In the rounded form of grooving the iron is not, as it were, "nicked," and has no such tendency to break as in the case of sharp-cornered rifling, which gives a line for fracture. What Captain Blakely says of the rounded grooves fouling less and being much more easily sponged, should not, I think, for the safety of the arms of the men loading the gun, as well as for that of the toes and bodies of those standing behind it, be overlooked.—R.A.E.S.

† Since changed to wrought iron.—R.A.E.S.

was rather over 1,100 ft. per second. With 90 lbs. of powder the same gun gave a steel round ball of 340 lbs. weight, a velocity on striking of over 1,600 ft., the ball hitting near the centre of the small piece of 11-inch plate fired at, indenting it 4½ inches, and owing to its being unsupported in the centre, splitting it in halves. This blow was undeniably by far the hardest yet struck at Shoeburyness, and was effected with much less strain upon the gun than in the case of firing the heavier elongated shot—which were far more difficult to raise for loading and required a very much greater force to send home in the gun. That the strain upon the breech in firing the elongated shot was much more, may be safely inferred, because the weight of the shot to be moved was far greater, and hence the pressure of the gas must be also much greater. A familiar illustration of this is afforded by loading the safety-valve of a boiler with a heavier weight, and then the steam requires to be of greater pressure, before the valve can be lifted; just so in the gun; and there is this further difference, that the elongated projectile has to be fairly pushed out, unthreading itself from the rifling, whereas the round ball rolls over on the first pressure of the elastic fluid, and at once relieves the gun. In cast-iron guns it has been found that after rifling they cannot use half their old charge with the same safety to the gun, as when fired with their full charge as smooth bores.

It is now time to briefly notice the different plans tried in this country to give rotation without rifling the gun.

Hogge's shot, which were amongst the earliest, were scored in front, and although some of them went tolerably straight, the greater part had little stability of flight, and of necessity, a short range. I need not describe them more particularly than to say that from Hogge's early efforts to Sir William Armstrong's late ones, to obtain rotation either by scoring the shot in front so as to be turned round by the air, or to be acted upon in rear by the powder, all attempts to fire with accuracy elongated shot out of unrifled guns have utterly failed.

The disc gun of Mr. Thomas Woolcombe, of Plymouth, is a very ingenious invention. The shot for this gun (Fig. 29) are, as the name of the gun implies, "discs," and are made so as to have their centre of gravity *not* in the centre of the figure. In loading, the heaviest part of the disc is placed on the upper side of the bore of the gun, and is pushed home in this position by a special rammer. On being fired it gives a very flat trajectory up to the first graze; but hitherto the accuracy obtained has been less than that from the ordinary rifled gun, and the shape of the projectile militates against its powder capacity; the penetrating power of the disc is however very great.

The Mackay Gun.

Length, extreme	11	feet	9	inches
Length of bore	10	„	1½	„
Thickness through breech	2	„	11	„
„ „ muzzle	1	„	2¼	„
Diameter of bore.....	0	„	8·12	„
Number of grooves.....	12			

Weight of some steel projectiles..	153 lbs.	....	length 12 inches
and of others	167 „	....	„ 13 „
Charge of powder	30 „		

The gun weighs 9 tons, and was forged hollow by the Mersey Company, and afterwards hooped from breech to trunnions.

Initial velocity given by	20 lbs. of powder and projectile of 100 lbs.	1508 feet
„ by	30 lbs. of powder and projectile of 112 lbs.	1640 „

The Mackay gun with an elevation of 12°, a powder charge of 25lbs., and a cast-iron shot weighing 129 lbs., gave a range of 3,735 yards. This cast-iron shot was square at the base (see Fig. N). The steel shot fired through the Minotaur target were cupped in the rear (see Fig. M).

Liverpool is the place where these experiments have been carried on, and where the gun was forged by Mr. Clay, who formerly constructed the celebrated Horsfall gun, presented to the nation (Fig. 12), and also made the gun (Fig. 15) which took the place of the piece of ordnance which so disastrously burst on board the American "Princeton." The charges which this gun withstood, viz., 44 lbs. of powder, are very great for a gun so light, especially considering that this was the first attempt at large ordnance made by the Mersey Company, and was the only powerful wrought iron gun made till many years afterwards. It cannot but be a cause of regret that there has been so little inducement given to them to continue the gun manufacture.*

Having thus briefly touched upon the various systems of rifling and the descriptions of guns made in foreign countries and at home, I may show how far the changes made, agree with what has been stated in this Institution, from which it may be fairly inferred that the ventilation of these questions is of great national advantage; and that, had this ventilation been earlier and more thoroughly made, a large portion of the money expended upon weapons, which are of small power and comparatively little value, would have probably been employed in developing the steel manufacture of this country, admitted by Sir W. Armstrong to be still far behind that of the great Prussian firm, represented by Krüpp.

I may remark that other countries have utilized the material already in hand, and expended very little upon new guns; but that England at once embarked in an entirely new manufacture, viz., that of Armstrong guns, and that it was pointed out in the beginning of 1861, at the very outset of this manufacture, that neither the system of construction, the rifling of the gun, nor its lead-coated projectiles, any more than the numerous tools pertaining to the weapon, were adapted for actual service. Later in 1861 the "leading" of the guns, and the delicacy of their whole mechanism began to attract attention;

* The Horsfall gun was fired at Shoeburyness with 74·45 lbs. of powder and a cast iron ball weighing 279 lbs., which got an initial velocity of 1620 feet per second, and gained the first victory over the Warrior target.—R.A.E.S.

and the shunt rifling and muzzle-loading were put forward, and on a war panic, an enormous number of cast-iron shunt-rifled guns were ordered for the navy; happily some of these were burst on the practising-grounds at Shoeburyness, instead of between the decks of our ships; and the war rumour having died away, the order was rescinded. After this the Armstrong guns were alone proceeded with, and their first generally known failure was in the cupola erected on board the "Trusty;" but on the first trial of the larger guns in actual warfare, happily not with foes "yard-arm and yard-arm," but where the ships could move as they liked, the breech-loaders entirely failed, as shown in the report from Kagosima.

A letter which appeared in the "Army and Navy Gazette" of April 30th last, signed by Sir W. Armstrong, inferred that the Admiralty were to blame for this failure through having allowed the old pattern vent-pieces to be used, but it did not state that the vent aperture in the 40-pounders was too small to admit of the new vent-pieces being used, and that there are nearly 300 similar guns out on service. Besides, as the gun is constantly undergoing changes, how is it possible to keep the vessels on foreign stations supplied with the latest improvements.

The construction of the guns has been very much simplified, and in several respects improved since the Arsenal manufacture was left to its proper development, for its chiefs have sought the very best mode of putting guns together, so that even in the limited competition in the Government manufactory of guns, as well as in the free competition in making plates, the country has already derived great benefit. It only now remains to have a "fair field and no favour" in rifling guns, for England to be in possession of what should be the best naval weapon in the world. And I sincerely believe that, were practical naval men appointed, a sufficient sum would be saved in the matter of ships' armaments, &c., to pay the additional cost of a standing navy, and to give the officers that increase of pay which they have been so long and so anxiously looking for.

Lastly, as to plated vessels, I think that erroneous notions of construction are prevalent, from the builders not being thoroughly acquainted with the mode of mounting and working naval guns, and the effects produced by their projectiles, and that hence they have laid too great stress upon the advantages of a thick wooden backing, with a thick armour plate in front of it. Now, Mr. Whitworth has shown us that he can so admirably temper and arrange the metal of his shells, that where he can put a steel shot, he can put a shell also; and it should be remembered that the effect of the explosion of powder always takes the line of least resistance, and hence on a thick plate being penetrated by a shell, moving at a high velocity, and being slightly turned from its direct course so as to close the aperture made, the force of the discharge will act upon the weaker skin of the ship (that is, upon the side proper of the ship), which will in all probability be blown inwards, and the backing set on fire, with a draught through the hole thus made, to keep up the flame. The plate also, in proportion to its thickness, will receive and transmit a greater shock to the

whole structure of the vessel, which, under a continuance of the blows of heavy shot, would be shaken to an extent endangering her safety. The plates, however, would certainly be so much damaged as to require removal, and the sides supporting them would, perhaps, be in nearly as bad a case.

The remedy for this is to put, say, a 6-inch planking of wood over the armour, coating it underneath with Jeffrey's marine glue, and caulking between the planks with the same material.

The wood (compressed pulp or paper would be better) in this position would serve as a buffer, to deaden and reduce the force of the blow: and to support the wood, so as to prevent its opening and spreading laterally, instead of being merely squeezed before the shot, there should be longitudinal stringers of thin iron, crossed by vertical stringers, into which the wood should be firmly packed.

An experiment was tried at Shoeburyness with an inch plate of iron placed in front of wood bolted on over 4½-inch armour, but having no iron stringers to support it: and although the indentations in the thick inner plate were less than half those usually made upon iron plates without this buffer, shells at last blew off the front plate, and destroyed the wood; but this was an experiment made with the advantage of a quiet concentrated fire upon one spot, and therefore very different to what would occur in an action at sea.

But were such an arrangement as that proposed carried out, the sides of vessels of the "Minotaur" class would be impregnable to foreign artillery, and though some of the wood would be doubtless knocked off, still it is not probable that two shots would strike on the same spot.

As to protection from vertical or plunging fire, the vessels of the "Minotaur" class are sufficiently large to admit of an additional inch of thickness of iron upon their decks, for which the necessity was seen in the case of the "Keokuck," at Charleston, sunk by one shot, which went through her deck and bottom; and more lately in the case of the Danish cupola ship so materially injured.

What, then, would be the position of an iron-clad, with a large shell striking upon her deck? The shell would go down through the vessel's bottom, and she would visit Davy Jones's locker, sinking, like the target ship at Portsmouth, which went down from a single 68 lb. shot hitting the underside of the armour plate, and being deflected downwards through her bottom.

We *have* already in our armour-clads a noble class of ships, with ports much higher out of water than the French ships, and sailors who I think it will be admitted are second to none. It only remains, therefore, to have the best guns, and the best means of working them, together with what is still more important, a thorough knowledge of their power, and of the tactics necessary for fighting our iron-clad navy.

I have already shown that excellent weapons are now being turned out from the Woolwich Arsenal, and that the shot, shell, and fuzes made there are very good, but I cannot say that we yet have that desirable means for fighting our guns, or that our knowledge of

tactics for "iron-clads" is not susceptible of improvement. In these we want a thorough ventilation, and perhaps a small naval committee, to encourage improvement, and point out where rewards would be most fitly bestowed, and I have little doubt that the stigma of not having even a good handbook for naval warfare would be soon removed, and with it the danger of going into action without having carefully studied and thoroughly understood what has to be done to bring the fight to a successful termination, and to make it a complete conquest with the least loss of life and damage to our ships (points hitherto too much overlooked). Were this done, England, as skilful in warfare as in iron manufactures and the arts of peace, would still hold her old and undisputed sway as mistress of the seas.

Commander DAWSON, R.N.: I should like to ask a question with reference to the American guns, whether the monster guns spoken of so favourably have any relation to the ones tried against Charleston, of which we read that they burst on the average at the fiftieth round. One is supposed to have reached the seventy-fifth round. I should like to ask if the lecturer is convinced in his own mind that he has good grounds for the statement he has put forth? I do not doubt that he himself is satisfied that he is uttering statements which he has received, but the question is whether he has received them from reliable sources. Again, with reference to the Southern States, I did not hear him describe the shot belonging to the Rodman gun; and as I have had the advantage of hearing a description of the shot from a Confederate officer, it may be interesting to add it to the lecture. The Confederate officer described the process of rotation as being given by a brass sabot, which was fastened to the shot by a spindle. The space between the sabot and spindle was filled up with grease; the sabot itself had a sort of saw edge with a corresponding edge in the rear of the shot. So that on firing the gun, the sabot fitted into the rear of the shot, and being forced out into the grooves, gave rotation; and on the shot escaping from the gun, the sabot fell off. The shot pursued its course without any attachment but the sabot spindle. This I had from the Confederate officer, and I suppose it is correct. With reference to our own guns, I think we ought to take with a certain amount of caution what our friend Captain Scott says about the Armstrong guns. We must remember that Captain Scott is an inventor; he has his own particular hobby, and his own particular class of guns. I should like to ask him with reference to this particular groove that he has put forth, with the rounded edge, whether any guns have been tried with that groove? and if so, what has been the effect as regards the accuracy and endurance of the gun? I must say it is a shame that in these days we should have so few large rifled guns in the navy. I have been struck with reading of the success of the French in cast-iron guns; and I understand that Mr. Bashley Britten has succeeded in rifling cast-iron guns with such success, that they produce good accurate practice with rifle shot; and what is still more extraordinary, that the rifling increases the accuracy of round shot fired from the same gun. I think it is a great point that we should be able to fire round shot from whatever is to be the future gun of the navy; because for almost all sea purposes spherical shot has a great advantage in the ricochet which you will never get from elongated shot. Another point on which I should like to chronicle my opinion is with reference to these monster guns. As a rule, I think that as yet, they are mere artillery curiosities. We have not yet had sufficient experience of their capabilities, except in bursting, to know that a 300-pounder or a 600-pounder will ever make a good weapon of war.

Captain HARRISON, R.A.: There is one remark that Captain Scott made shortly after I came into the room, with reference to which I should like to ask on what authority he obtained his information; because I have heard it distinctly contradicted. He said the French have guns—I do not speak of experimental guns, which I think is very probable—but that they have guns which will penetrate four and a half inches of armour plate at 1,000 yards. I was distinctly told on very good

authority that a French naval officer in this country on being asked that question laughed at it. He said, "We certainly have an experimental gun which has done this amount of penetration: but that we have guns which will do that amount of work, is all nonsense, we have not got them." I was also told that so much faith have the French in rifled cast-iron guns, that they are not allowed to fire them except when in action. Such is the opinion they have of their cast-iron guns. With reference to what Captain Scott has said about the competitive Armstrong guns at Shoeburyness, that they completely differ from the breech-loading service gun; so far as I am informed, it seems to me that in the alteration which has been made, it has been a decided disadvantage; because the competitive breech-loader is inferior in every particular to the one in the service now. On the other hand, I never understood that Sir William Armstrong ever objected to the use of steel. Commander Scott seems to think that the introduction of steel had arisen since Sir William Armstrong left the arsenal. I always understood Sir William Armstrong said, "Let us have steel lining as soon as we find we can rely on steel." Query: up to this time has steel been at all reliable for ordnance to stand heavy charges? Take for instance the Prussian steel gun; the charge for that gun is simply 5 lb. Has Commander Scott information of any large steel guns—I do not mean to say that plenty have not been made—but can he give us any information of the number of rounds those guns have stood, and with what charges? The whole question turns upon that. If he cannot, have we been wrong in using wrought iron guns? for certainly we have not seen yet that steel tubes have been as reliable as those of plain wrought iron.

Rear Admiral HALSTED: With respect to the statement just made by my friend Captain Harrison, I would ask him to be good enough to inform us how it is, in a question which is so absolutely critical between the principles of the Armstrong gun, and the principles of the Whitworth gun, representing the polygonal system, that the Government have not put into the pending competition a single gun of all those for which they have paid hard upon three millions of money? and how it is, that the gun with which Sir William Armstrong is now competing, is so absolutely different from his guns in the services, that no pattern whatever of such guns has ever been previously constructed in this country? The service gun consists of two distinct characters, a long gun and a short gun. Neither the long gun nor the short gun, *i.e.*, neither the long gun built upon the pattern of 1860, nor the short gun built upon the pattern of 1863, are represented at the present moment in that contest against the Whitworth polygonal gun. Captain Harrison himself says that neither of these patterns are there. It certainly seems a very wonderful thing, when Sir William Armstrong is challenged for the first time openly, or rather when he accepts for the first time openly a challenge such as that now pending that then he fails to put forth any single sample of any gun which the three millions have purchased from him for the country. I hope Captain Harrison will explain what he means by the distinct assertion that the service guns are better than those which are now being put forth at Shoeburyness by Sir William Armstrong.

Captain HARRISON: I will repeat what I said. I understood Commander Scott to lay great stress upon the fact that Sir William Armstrong had substituted a different breech-loader for our service breech-loader. My remark was this: that so far as I understood, there was no alteration in principle; inasmuch as the breech-loader now in competition at Shoeburyness was a coil gun simply, with a steel-tube inserted.

Admiral HALSTED: No.

Captain HARRISON: This is what I wished to say, that so far as my information goes, the breech-loader at Shoeburyness is a coil gun with a steel tube inside; that if that were the case, Sir William Armstrong had not departed from his principle, because in the very first letter which he wrote on the subject, and which is published in the Report of the Ordnance Committee that sat in the House of Commons, he distinctly stated, that as soon as steel could be obtained of a reliable nature, he wished to use it as a lining for his gun; that at that time he could not rely upon it; therefore he considered the gun ought to be made of hooped iron. That was my first remark regarding what Captain Scott said, that if it be true that the

present competition gun is a coil gun with a steel tube, I did not consider it a departure from the Armstrong principle. Secondly, that even supposing it was, it did not appear to me that Sir William Armstrong had gained by the change, inasmuch as the breech-loader which he at present uses at Shoeburyness is inferior to our service breech-loader; therefore, that Sir William Armstrong would have done much better to have stuck by his old plan, and have used the service gun.

Admiral HALSTED: Permit me to say, that there is nothing more than your statement to shew that the service gun is better.

The CHAIRMAN: We are not now discussing the Armstrong gun; we are discussing the subject raised by the lecturer, the progress of ordnance abroad. You are making this a personal question.

Admiral HALSTED: Permit me to say, that I do not think you are right in bringing me to book, and saying that I am making this a personal question; I am only answering the speaker.

The CHAIRMAN: I do not think you have a right to speak a second time.

Admiral HALSTED: That is another thing. You stated that I had made a remark that was personal.

Rear-Admiral Sir F. NICOLSON, C.B.: I am afraid that our discussion is becoming very heated; and I am quite sure my friend, Admiral Halsted, would be the last to raise anything like a discussion in which any expression that fell from him, quite accidentally, should be objected to. I think it would be a great pity if in his ardent advocacy of one system of guns, he should make us depart from the rule which our Chairman has laid down.

Admiral HALSTED: I did not make it a personal question. Captain Harrison made a statement which I knew to be wrong. He is misinformed, no doubt. It is not a coil-gun, and I merely asserted that it is not a coil-gun.

Mr. J. W. GIRDLESTONE, C.E.: I should like to ask Captain Scott if the screw bolt alluded to as the invention of Captain Palliser, where the part of the bolt on which the thread is cut is of larger diameter than the other part, is supposed to be new in principle, or in its application only for securing armour plates on ships; I suppose the latter, for I myself once showed on some drawings, not a bolt for armour plates, but a screw, where the part on which the thread was cut was of so much larger diameter than the other part of the screw, by the thickness of the thread; which drawings I laid before the Ordnance Select Committee some two years since.

With respect to Mr. Mackay's gun, which has been mentioned this evening, where the shot rotates by the action of the gas, the projectile used being, I believe, only one and a half diameters in length, I would suggest that even if the gas will give sufficient rotation to such a projectile, which I imagine is too short for general use, that it does not follow that it will give anything like sufficient rotation to a projectile of two and a half or of three diameters in length; the projectile having no grooves of any kind on it.

Captain J. H. SELWYN, R.N.: I am anxious to say a word before this meeting, in view of what has been stated in a leading journal within the last day or two, with respect to the naval action fought off Heligoland. That leading journal took occasion to inculcate, with the authority of one who holds the pen with great ability, but who I doubt has ever held the trigger lanyard, the system of long balls as opposed to "close quarters." I do say it is a most dangerous thing for the naval supremacy of this country, that the very talented members of the press should fancy themselves such authorities on such a subject, as to lay down such utterly false premises, and to draw from them such still more false conclusions. It is dangerous, for this reason: young officers are now perhaps better read in the daily journals than they are in the history of their profession; and they are too apt, with the great mass of the British public, to follow the lead of a gentleman, who sitting at home at ease, fancies himself entitled to write of all things, in all places. It is not many months since, that in this Institution a gallant Admiral, whose age and whose experience entitle him to the utmost attention, got up and distinctly laid down as a rule, what I think most naval men of experience will join him in announcing, that no naval action ever was or ever will be *decided* at long ranges. It is

perfectly true, that owing to that trajectory, which some writers in the journal I refer to, also despise as a piece of professional slang, long range guns will occasionally do considerable damage to ships, when the shot strike them on the decks, but not on the armour; but the gun which cannot pierce armour at 200 yards, cannot be expected to do so at 2,000. If any gentleman connected with the press will be kind enough to watch shot falling at three miles distance, and tell me how many of them strike and where they strike, then I shall be obliged to adopt his opinion, and condemn the tactics of the Austrian frigate in running in between her two antagonists and giving them as much as she could, though in that case, as in almost every other, two to one proved too much for her. Though the Prussian gun-boats took part at long balls, yet we learn that they went away, *hoping* they had done the enemy a great deal of damage, but utterly ignorant as to what that great deal was. If any English officer, having fought an action under such circumstances, were to come home to England, saying he *hoped* he had done a great deal of damage to his enemy; he would not be received with those cheers and acclamations, and those laurels which it is the hope and pride of every English officer to deserve. Captain Dawson said, in the course of his argument against what Captain Scott had stated in his lecture, that the guns which Captain Scott advocated were advocated by him because he was an inventor. Now, I must say that it is not a fair thing in any profession for members of that profession to get up and say that because one of their number has turned his attention particularly to this or that subject, and has arrived at a conclusion which day by day is being demonstrated to be more correct, that he is to be regarded simply as an inventor; that he is advocating his own principles; and that he cares nothing about the public service. I do believe that any officer in that position thinks first how he may benefit the service, and next how he may benefit himself. I am sorry to say that in the majority of instances those who do most for the service spend the most money with the least benefit to themselves. I think it is open to the recollection of every one here present that those guns such as Captain Scott advocated, the old cast-iron guns rifled on a particular principle, have been tried with very considerable endurance.

Captain FISHBOURNE: Not advocated.

Captain SELWYN: Captain Scott has advocated a particular principle of rifling cast-iron guns.

Captain FISHBOURNE: Not cast-iron guns.

Captain SELWYN: I did not say advocates cast-iron guns. I said rifled on the principle which Captain Scott advocates.

Captain DAWSON: I did not allude to his principle of rifling. I did not understand him to advocate his own principle of rifling at all.

Captain SELWYN: Then one of us misunderstood the question. I hope it was myself; because Captain Scott will be happy to hear that there is no objection to his rifling. But that system of rifling is one which, to a mechanical mind, must commend itself, because the whole force is communicated in the direction of the line in which rotation is required. It is at the first blush the great excellence of that form of grooving which has led to its adoption in the Jacob rifle, in small arms, and in other arms of the same character. It has next, that which Captain Dawson admired particularly, the power of firing round balls with the least possible injury, and, moreover, with the least possible windage, which is a very valuable condition. Granted that the edges of the grooves must not be injured, then that is the only groove which, with small windage, is capable of firing round ball. The French gun was adverted to by Captain Harrison as a doubtful specimen. I must say that it appeared in journals whose reputation entitles them to credence on such a subject, that that gun did pierce iron plates of the thickness adverted to by Captain Scott at 1,000 yards.

Captain HARRISON: I referred to guns.

Captain SELWYN: I have yet to learn that the French have constructed any other gun. If one gun will do it, that is quite sufficient for our purpose. We only want to know that there is a gun that will do this at such a distance without being damaged or injured. That it does so with diminished powder charge is very little to the purpose, because the effect produced is what we seek. If Sir William Armstrong

has not infringed upon his principle by adopting a steel tube, may I ask to what thickness the steel tube is to go before the coils are considered eliminated altogether? When are coils to cease to be considered the great feature of Sir William Armstrong's principle, as he has himself announced them to be? and when is the internal steel tube to be allowed to take their place? Again, it is said that Sir William Armstrong was ready to take steel whenever he could get it. Now, at a lecture which I am sorry to say was very thinly attended, given here by Mr. Bessemer, he stated to us, what he has stated long ago to the Government, that he could give them steel of any quality they desired, from the same quality as the best and softest wrought iron upwards to the hardest steel, by a mere alteration of the proportional parts of his materials; that he could do so for the Government at £7 per ton. Was this gentleman not equally well worth considering and treating with as another who professed to give us coils which would never weld, which never could be welded between the bars, and which have failed and will fail as long as they are used? And should we have spent three millions of our money less usefully by giving a proper proportion to the development of a metal which promises us the greatest tensile strength? Captain Scott has given a very able *résumé* of the principal features of foreign artillery; but I must draw attention to the fact that in no instance do we see in the foreign artillery any great improvement or advance upon what we know ourselves, unless it be in those instances where they have taken the most valuable principles of our own inventors, and so far demonstrated the value of them as to induce our Government to send officers abroad to look at guns, the designs for which, if not the guns themselves, were made at home.

Commander Scott: I think Captain Selwyn has left me very little to answer. Captain Dawson seems to have entirely misunderstood what I meant. He says I spoke in favour of cast-iron. On the contrary, I spoke of cast-iron being given up as a metal fit for powerful rifled guns. I said the Americans had already commenced the mild steel manufacture, had paid a large sum for the patent to Mr. Bessemer, and had an agent over here to be instructed in the manufacture. I must say I cannot understand the purport of Captain Dawson's remarks. He said, on the one hand, that he wants a big gun for the navy, and, on the other, that he does not want a big gun; and then he said that monster guns with a sufficient endurance cannot be made. He also appears to infer that I do not want to fire round shot; whereas, if he had paid attention to what has been said over and over again in this Institution, he would have learnt that the very principle I commenced with was that we had got a good missile in the round ball; that we knew precisely what it would do; and, therefore, it was folly to give up what we knew was good to go after something else, the value of which we did not know. Besides, I called attention to the fact that the very first trial of the Armstrong gun proved it to be inferior to the 68-pounder at close quarters; and I said that for a naval gun you must have the round ball as well as the elongated projectile, but that the first thing was to fire the round ball well, and in my letter to the War Department in 1859 I stated that "the round ball will always finish naval actions." Although I am one of those whom Captain Dawson has kindly stigmatized as an inventor, I must say, that as one of the early gunnery officers, and having paid such attention to the subject that I was enabled publicly to state in 1860 that the plans of Sir William Armstrong were not adapted for naval guns, it became almost imperative upon me to show that they were so. This endeavour has cost me a considerable sum of money, for I had to pay for all my early experiments, because I happened to be a naval officer instead of a civil engineer. If Captain Dawson could point out to me where I have gained in this matter, I shall be particularly obliged to him. With reference to the remarks as to where the steel is in Sir William Armstrong's competitive guns, the simple fact is that they are steel guns. They have a solid steel barrel all the way through till you come to the trunnions, and there are little coils put on, one apparently for the trunnion-holder, and the others I suppose for a make-weight over the breech. Had the service 12-pounder been so satisfactory as was said, Sir W. Armstrong would scarcely have gone from a good thing to a new plan. But he had not a good thing, for the service guns are continually failing. As I have adverted to this, I had better take the official Report and just glance at the performances of the Armstrong guns at Kagosima, and the mishaps that happened to them.

The Report speaks of precisely the same thing: of the vent-pieces sticking in the bore from the tin cup being forced back over their nozzles, just as Captain Fishbourne showed to have occurred at Newhaven. The breech expands when warm, and then the tin cup is jerked over the nozzle of the vent-piece, which necessarily sticks fast, and cannot be got out without mechanical appliances. This misfortune did not occur to Racehorse's (Captain Boxer's) gun only, but it occurred also to the guns of the other ships at Kagosima. I have only now to explain about Captain Palliser's bolts.

Captain FISHBOURNE: And the French gun?

Captain SCOTT: As to the French gun, Captain Harrison has one report and I have another, and I believe mine to be correct. Captain Harrison likewise spoke of the Prussian steel gun as not reliable. I am informed that the Prussians are making them in large numbers, and hence I conclude that they are good guns. They are just like those from Krüpp, which have been so successful in English trials. I got the information as to the performance of these guns from different sources; and I also got information from America and other places, of their artillery, but still it is extremely difficult, as Captain Harrison knows, to get information which can be fully relied on. I have no official report, as I have in the case of the Armstrong guns at Japan.

Captain HARRISON: The only question is whether the Prussian guns are making or made?

Captain SCOTT: Making. I was informed that they were going on with them as fast as possible.

Captain HARRISON: Not made?

Captain SCOTT: I have no doubt several of them are by this time, but how many I cannot say.

Sir F. NICOLSON: Have they all been tried?

Captain SCOTT: Several have been tried. As to the "raised screw thread," Captain Palliser only applied the plan for holding armour-plates, and I think great credit is due to him for this novel application of a principle, which is all he claims. It has been, as far as yet tried, eminently successful. I think I have now answered all the questions, in which Captain Selwyn, like a true sailor, has not only kindly helped me onward, but cheered me on the road.

The CHAIRMAN: It only remains for me to ask you to join me in thanking Captain Scott for his lecture. Lectures of this description take about an hour and a half to deliver, but I am sure they take many hours to study and to write. We see the wheat after it has been sifted through the sieve. Captain Scott has been sifting the wheat for us, and it is rather a long process. As Englishmen, I think we may be satisfied with what he has shown us. We seem to have gone through a long course of experiments, gradually and gradually improving; and it is satisfactory to know that all the countries,—France, Russia, Austria, Prussia, except Italy, Spain, and Portugal,—have gone through the same course of disappointment, and have worked their way up to their present position.

NATURE OF GUN.	Powder charge.	PROJECTILES.			Velocity at 30 yards.	Initial velocity.	Remarks.
		Nature.	Weight.	Diameter			
	lbs.		lbs.	in.	ft.	ft.	
32-pr. Rifled Shunt, 59 cwt., cast-iron gun	5·8	Elongated shell	54	6·35	1215·7	1224·5	Mean of 4 rounds.
" " "	5·8	" "	54	6·35	1122·1	1136·3	Mean of 3 rounds.
32-pr., 59 cwt., Smooth.....	5·8	Cylinder	54	6·35	1187·4	1201·0	
12-pr., A, 8½ cwt.	1·6	Elongated shell	11·9	3·074	1108·4	1111·8	
" "	1·8	" "	11·9	3·074	1238·8	1248·2	
" "	1·8	" "	11·9	3·010	1200·	1209·7	Same shell, lead reduced to the same diameter as the gun, except a ring 0·25 of an inch in length at the base.
68-pr., 95 cwt.	16·	Round ball	66·4	7·91	1553·8	1579·0	
" "	"	Round shell	51·8	7·91	1769·4	1809·9	
32-pr., 58 cwt.	10·	Round ball	31·6	6·17	1653·	1690·0	
12-pr., 18 cwt.	4·	"	12·10½	4·52	1718·	1769·8	
12-pr., 6½ cwt.	1·4	Elongated shell	8·12	4·55	1124·2	1163·4	
12-pr., A., 8½ cwt.	1·8	" "	11·9	3·084	1180·9	1190·2	

NATURE OF GUN	Powder charge.	PROJECTILES. Nature.	Weight.	Diameter.	Velocities.	
	lbs.		lbs.	in.	ft.	
Horsfall's Smooth Bore { wt. 24¾ tons, bore 13·014 in. }	74·45	Round ball	279·5	1	1631·0	Initial.
300-pounder { shunt rifled } { wt. 12 tons bore 10·48 in }	50·0	"	150	10·41	1750·0	"
" " "	50·0	" wrought iron ..	162	" "	1700·0	"
" " "	45·0	" " ..	163	10·337	1627·0	At 508 feet from gun.
" " "	50·0	" steel	168¼	10·43	1593·8	At 510 feet from gun.
" " "	45·0	Elongated steel shot....	301	10·46	1254·5	" "
" " "	35·0	" cast iron	308	..	1096·0	" "
Lynall, Thomas { wt. 18 tons, bore 9·0 in. }	50·0	" steel.....	327	..	1222·0	At 546 "
Shunt rifled { bore 9·22 in., wt. 12½ tons. }	44·0	" "	221	9·14	1461·1	At 510 "
" "	30·0	" "	221	9·14	1292·6	" "
" { bore 7·0 in., wt. 6¼ tons. }	25·0	" "	100	6·91	1507·2	" "
Big Will, 600-pr. { bore 13·3 in., wt. 22¾ tons. }	90·0	Round ball "	344	..	1589·0	At 600 "
" " "	70·0	Elongated shot, cast-iron	513	13·25	1255·0	At 120 "
" " "	70·0	" shell, steel ..	610	..	1143·0	At 2910 "
" " "	70·0	Round ball, cast-iron ..	304¼	13·2	1273·3	At 510 "
Committee Gun for lead-coated shot of Messrs. Britten & Jeffrey { bore 7·1 in. wt. 6 tons. } ..	16·0	Elongated shot, steel ..	119	..	1273·3	" "
Whitworth's 120-pr. { bore 7 × 6·4 in., wt. 7½ tons. }	27·0	" shell " ..	149·5	..	1283·4	" "
" " "	23·0	Elongated shot " ..	129·0	..	1278·5	At 1740 "
" 70-pr. { bore 5·6 × 5·2 in., wt. 3¾ tons. }	12·0	" "	68·8	..	1275·8	Initial.
Scott's 120-pr. { bore 7 inches, wt. 7½ tons. }	25·0	.. ..	110·0	..	1584·0	"
" " "	12·0	.. ..	110·0	..	1270·0	"
French " "	25·0	.. ..	110·0	..	1550·0	"
" " "	12·0	.. ..	110·0	..	1256·0	"
Parrott's 100-pr., bore 6·4 in.	11·0	.. ..	80·0	..	1406·0	"
Rodman's 15-inch, bore 15·0 in.	60·0	Round ball, cast iron ..	400·0	..	1480·0	"
" " "	40·0	" "	315·0	..	1250·0	"

The Journal

OF THE

Royal United Service Institution.

VOL. VIII. 1865. APPENDIX.

PROCEEDINGS OF THE THIRTY-FOURTH ANNIVERSARY MEETING.

THE THIRTY-FOURTH ANNUAL MEETING of the Members was held in the Theatre of the Institution, on Saturday the 4th March.

His Grace the Duke of Somerset, K.G., First Lord of the Admiralty in the Chair.

I. The Secretary read the Notice convening the Meeting,

II. The Minutes of the Proceedings of the Thirty-third Anniversary Meeting were read.

III. The Minutes of the Proceedings of a Special General Meeting held on Monday May 2nd, 1864, were read.

IV. Captain SIR JOHN HAY, Bart., R.N., M.P., F.R.S.—

The Report which is about to be presented to you will naturally attract some attention on account of one omission. Since it was prepared the Institution has had the misfortune to lose its President, the late Duke of Northumberland, and it was only in consequence of the fact that the Report was printed, and was in a position to be submitted to the meeting, that it was not thought advisable by the Council to have it altered and reprinted for the purpose of calling attention to that great loss, But I think if the course which I, as Chairman of the Council, would venture to recommend to the meeting be adopted, perhaps even a greater mark of respect will be shown to the memory of our late President. You are well aware of the fact of the great interest which our late President took in all scientific matters connected with the Navy. Holding very high rank in that profession, and having served with some distinction as a junior officer up to the time of his becoming a captain, at the close of the late war, his memory was remembered with great satisfaction in the Navy. From that time his duties as a large landed proprietor, combined with his love of science and the absence of any services that would require his active presence afloat, led him to devote his life to other avocations. But his connection with the Navy was still maintained, because it will be in your recollec-

tion that during the years 1852 and 1853 he held the office of First Lord of the Admiralty. He was also a most munificient patron of this Institution. Several considerable donations have been given by him towards the completion of this Theatre, and towards the model of the Battle of Trafalgar. In 1841 he gave us a large collection of maps, and in 1850 a collection of arms, models, and astronomical instruments. What we therefore propose to do in recollection of his services and his connection with this Institution, is to ask this meeting to adopt an address in the form of a letter of condolence to his widow, the Duchess of Northumberland. If the meeting will allow me, I will read the form of letter which has been adopted by the Council to be submitted to you; and if it should be, as I trust it may be, adopted unanimously by this meeting, we would ask your Grace to place it in the right channel.

"Madam,

"The Council and Members of this Institution desire to express to your Grace the great sorrow which they feel for the death of their late President, and to condole with you on your irreparable loss.

"During many years his position as their honoured head has been a tower of strength to this Institution.

"His kind courtesy, and his munificent patronage, and love of literature and science, alike endeared him to both the Army and Navy, and the memory of the late Duke of Northumberland will long be treasured by the Members of the Royal United Service Institution."

What I, therefore, have to do is to propose this Resolution:—

"That this meeting do adopt this Address of Condolence to her Grace the Duchess of Northumberland on the death of his Grace, the President, and that his Grace the Chairman, be requested to communicate the same to the Duchess."

Lieut.-General the Hon. Sir EDWARD CUST, K.C.H.—

My Lord Duke, it is a melancholy gratification to me to be called upon to second this Resolution, inasmuch as the Duke and Duchess have been my personal friends for a great many years. I had a sincere regard for him personally, and have enjoyed his hospitalities both in town and country. And I esteem most sincerely the Duchess to whom we are about to offer this address. She has some claim to share the good actions of her husband, for she was renowned even before her marriage, for her active and zealous desire to do good in every possible way. It was this benevolence of her character, which was, I believe, the origin of the acquaintance between them. And there is no doubt that, even to the last, her anxiety to be an excellent wife was shown in the desire to do the duties of a nurse, until it was actually required by the physicians that she should relinquish the office to another person. I would also beg leave to add a few words upon the character of the Duke, because he has really acquired a place in the thoughts of every one throughout the country, and with very great justice too. It is well-known to you all, that it is an old custom at the funerals of the great nobility for the herald to proclaim the style and titles of the deceased nobleman. There is no doubt the names of Percy, Lucy, Poynings, and Latimer, and all the titles which rested on his Grace's head, were interwoven with the history of this country, and with the ballad music and literature of England. But I do think that the heraldic style and titles of the Duke of Northumberland, great as those titles were, sink into utter insignificance and may be passed over, when compared with such style and titles as these:—"The late Duke was a Fellow of the Royal Society, of the Society of Antiquaries, of the Royal Geographical Society, and a member of the Royal Astronomical and other learned societies. He was also a munificent supporter of many of our charitable institutions, was President of the Westminster and Middlesex Hospitals, Vice-Patron of Charing Cross Hospital, President of the Seamen's Hospital Society, President of the Westminster General Dispensary, Vice-President of the Royal Humane Society, President of the Royal National Life Boat Institution, Vice-President of the Royal Naval Benevolent

Society. His Grace was also President of the Royal United Service Institution, President of the Royal Institution of Great Britain, a Director of the British Institution, and a Trustee of the British Museum." The Duke of Northumberland, as Sir John Hay has stated, was not, after he retired from the service, at all one of that class of gentlemen of England "who live at home at ease," and care nothing for "the dangers of the seas." Subsequently to that period his life was passed in every possible way connected with the profession.

"His Grace was very anxious, when he found his health was failing, to complete a large and magnificent scheme that he had long contemplated, for the education of the children of fishermen and seamen on the coast of Northumberland, and it is stated that the endowment of schools in the villages of Whitley, Tynemouth, Percy Main, and at North Shields, was completed before his death. The Duke of Northumberland built the Tyne Sailors' Home at a cost of upwards of 7,000*l*. He also established life-boats and life-boat stations at Hauxley, Tynemouth, Cullercoats, and Newbiggin, and was a magnificent supporter of all local charities." In fact, the whole of his career seems to have been that of a noble sailor. It may be said of him that he carried his uniform not only on his back but in his heart. Nor was it only to subjects of this kind that the Duke lent his attention, he was a great lover of science, and he was a remarkable traveller. Indeed, it may be said of him emphatically, that "he was learned in all the wisdom of the Egyptians." He was among the first who went up the Nile and examined Thebes and all those places which are now so commonly visited as to have lost part of their interest. And if I am not misinformed he brought from that country, and enriched with it the national collection at the British Museum, one of the oldest marbles known, a marble, supposed from his knowledge of Egyptian hieroglyphics, to have the mark of the cartouche of the Pharoah of Moses. These facts evidently show that he was by no means an ordinary kind of man. We all feel that when men of high station condescend to make themselves useful in their profession, that they are entitled to the esteem of their fellow-countrymen. And I am sure, my Lord Duke, that by none are such men esteemed more than by yourself, who in an office comparatively strange to you, have brought to it an intelligence, an activity, and an industry which have obtained for you the confidence and esteem of the Naval profession.

The Resolution was put from the Chair and carried unanimously.

The Duke of Somerset—

I shall of course feel it my duty to communicate this address of condolence to the Duchess of Northumberland. With reference to the late Duke, it is unnecessary that I should say a word, because the feeling with regard to him is so general and profound. I can confirm, however, what has just been spoken by Sir Edward Cust, because being myself a Trustee of the British Museum, I can bear testimony to the liberal gifts that his Grace has made to that Institution, doing that which only his Grace's wealth and liberal mind, combined with knowledge really appreciating what was valuable in that Institution, enabled him to do.

V. The Annual Report of the Council was read as follows:—

1. In submitting this, their Thirty-fourth Annual Report, the Council have the pleasure of congratulating the Members on the increasing prosperity of the Royal United Service Institution.

Members.

2. The number of Members who joined the Institution during the year amounted to 215. The loss by death has been 100; 53 have withdrawn; and the names of 7 have been struck off the list, their

subscriptions for upwards of two years, though more than once applied for, remaining unpaid. The increase on the year therefore is 55. A detailed statement of the changes amongst the Members, and a tabular analysis of the present and past state of the Institution, will be found at pages xvi and xvii.

Finance.

3. The usual Abstract of the Yearly Accounts, as audited on the 27th of January, is given on the following page.

Receipts.

4. The Receipts have exceeded the estimated amount by £419. The annual subscriptions above 10*s*. have amounted to £137 beyond the estimate; the entrance fees to £65; and the sale of the Journal to £38. The sum of £9 has been received in donations.

GENERAL ABSTRACT OF THE ACCOUNTS OF THE ROYAL UNITED SERVICE INSTITUTION FROM 1st JANUARY to 31st DECEMBER, 1864.

EXPENDITURE.

		Amount. £ s. d.
Secretary's Salary		200 0 0
Accountant's ditto		90 0 0
Clerk's ditto		52 0 0
Servants' Wages		344 14 6
Ditto Clothing		44 19 6
Insurance		29 5 0
Fuel		64 8 6
Lighting		33 6 10
Ground Rent		205 3 9
Assessed Taxes		75 15 11
Parish Rates		94 5 0
Water Rate		10 0 0
Annuity to Malcolm		20 0 0
Journals		687 11 10
Postage { Journals	140 1 8	
Postage { Letters	27 7 0	
		167 8 8
Library		116 18 11
Museum		71 10 11
Topographical Room		21 17 6
Advertisements		41 17 5
Artificers		85 14 5
Lectures		39 11 9
Printing Circulars and Stationery		71 13 5
Receipts and Postage Stamps		3 1 1
Miscellaneous		17 3 1
Domestic Sundries		17 13 10
Petty Cash returned to Bankers		3 15 10
Total Expenditure		£2,609 17 8
Cash repaid to Agents		17 2 6
Charges from "		1 17 10
Invested in purchase of Stock		212 0 0
" " 5 per Cent. India Stock (Reserved Fund)		723 12 6
Balance at Bankers, 31st December, 1864 { Income	76 14 9	
Balance at Bankers, 31st December, 1864 { Life	53 0 0	
		129 14 9
Total		£3,694 5 3

RECEIPTS.

		Amount. £ s. d.
Balance at Bankers, 31st December, 1863		172 3 3
Annual Subscriptions, at 10s., for 1864	666 15 3	
" " above "	1,737 2 6	
" " arrears	8 10 0	
" " advance	13 10 0	
		2,425 17 9
Entrance Fees		215 0 0
Dividends		103 18 1
Donations		9 0 0
Grant from Government		400 0 0
Sale of Journals		98 1 4
Sale of Waterloo and Sevastopol Models Pamphlets		1 9 0
Balance of Petty Cash returned to Bankers		3 15 10
		£3,429 5 3
Balance of Life Subscriptions in hand, 31st December, 1863		43 0 0
Life Subscriptions received during 1864		222 0 0
Total		£3,694 5 3

Examined and found correct, J. E. A. DOLBY, THOS. SMITH, H. F. DOWNES, J. D. MACQUEEN, Captain, } Auditors.

GEO. FELSTEAD, Accountant.

27th January, 1865.

Estimate of Probable Receipts and Expenditure for 1865.

Expenditure.	Amount. £	s.	d.
Secretary's Salary ..	200	0	0
Accountant's do	90	0	0
Clerk's Salary	52	0	0
Servants' Wages	370	0	0
Servants' Clothing ..	45	0	0
Insurance	29	5	0
Fuel	65	0	0
Lighting	35	0	0
Ground Rent	205	10	0
Assessed Taxes	100	0	0
Parish Rates	100	0	0
Water Rate	10	0	0
Annuity to Malcolm ..	20	0	0
Journals	700	0	0
Postage thereof	150	0	0
Library	100	0	0
Printing Catalogue thereof	250	0	0
Museum, including Models of Ships, Guns, &c. ..	250	0	0
Topographical Room ..	50	0	0
Advertisements	40	0	0
Artificers	100	0	0
Lectures	50	0	0
Printing Annual Report and List of Members ..	80	0	0
Printing Circulars, Stationery, &c.	80	0	0
Postage	40	0	0
Receipt Stamps	3	0	0
Miscellaneous	50	0	0
Domestic Sundries ..	20	0	0
	£3,284	15	0
Balance ..	45	5	0
Total.. ..	£3,330	0	0

Receipts.				Amount. £	s.	d.
Annual Subscriptions:						
At 10s. ..	670	0	0			
Above ..	1,700	0	0			
				2,370	0	0
Entrance Fees				150	0	0
Dividends..				150	0	0
Sale of Journals				60	0	0
				£2,730	0	0
Grant from Government .				600	0	0
Total.. ..				£3,330	0	0

Expenditure.

5. The Expenditure has fallen within the estimate by £368. In the publication of the Journal (including the Report and List of Members), by £163; in the Library, by £54; Museum, £29; Topographical Department, £29; Artificers, £55; and Miscellaneous Expenses, by £33.

During the past year, the Council, by reducing the Expenditure of the Institution so far as compatible with the efficient administration of its affairs, have been able to invest the sum of £700 in India Five Per Cent. as a "Reserved Fund," whilst the question of Building, which would entail a large outlay, is in abeyance.

Life Subscriptions.

6. The balance of £43 at the end of 1863, and the Life Subscriptions received during 1864 amounting to £222, have, with the excep-

tion of a balance of £53, which will be similarly dealt with, been invested in Government Securities.

The funded property of the Institution in Three Per Cent. Consols and Five Per Cent. India Stock amounted on the 1st January, 1865, to £4,516 16*s.* 4*d.*

Government Grant.

7. The Council have great satisfaction in informing the Members, that in answer to an application requesting, on behalf of the Naval Service, a contribution from the Lords Commissioners of the Admiralty towards the funds of the Institution, they have received a communication that their Lordships propose to subscribe annually £300, on the understanding that a similar grant be made in the Army Votes; and that the Lords of the Treasury have been requested to sanction the insertion of that sum in the Naval Estimates for the year 1865–66.

From the Right Honorable the Secretary of State for War, the Council have received intimation that, instead of the grant of £400 hitherto made, only £300 will be provided in the Army Estimates, but on the understanding that a similar sum be also contributed from the Naval Funds. To this arrangement, as explained above, the Lords Commissioners of the Admiralty have agreed; and the Government grant has thus been raised from £400 to £600 per annum.

It is a subject of congratulation that the Institution is now substantially recognised by the Naval as well as the Military Departments of the country; and the Council take this opportunity of expressing their best thanks to those Departments.

Lease of the Premises.

8. The lease of the front portion of the premises occupied by the Institution having expired on the 5th April 1864, the Council entered into an agreement with the First Commissioner of Her Majesty's Woods and Forests to occupy that portion at the former rent of £205 10*s.* per annum, paid quarterly, the occupancy to terminate on a quarter's notice given by either party. No official information has been received by the Council as to whether the present site will be granted by the Crown; but the Council have reason to hope that the present site may be retained, with an offer of increased space. Should such be the case, and a new street from Whitehall to the Thames Embankment (by which the position of the Institution would be greatly improved) be opened, the Council will submit to the Members a plan for the erection of an improved building. A scheme for raising the necessary funds will be brought forward when the arrangements have been further developed.

The Journal.

9. The Council have, in former reports, expressed their opinion of the great importance of this publication, and each year strengthens them in that conviction. Not only is it more and more appreciated by the Members, but its increasing sale proves the greater estimation in which it is held by the public.

It may fairly be stated, that the Journal forms a considerable, if not the chief, inducement for Officers of the Services to become Members; conveying, to them, as it does, at a distance from the metropolis, or whilst serving abroad, special information on the naval and military questions of the day which they are unable to obtain from any other source.

The value of the Journal would, however, be much enhanced if Members of scientific attainments residing at a distance, and not having the opportunity of themselves reading papers at the Institution, would forward memoranda suitable for the Lecture Room or for publication.

The Lectures.

10. The Lectures delivered and papers read during the past session, have been as valuable as those of any former session; and the Council tender their thanks to those gentlemen who have placed their time and talents at the disposal of the Institution. The importance of affording to the Officers of Her Majesty's Services, and scientific men generally, opportunities for meeting and discussing the varied questions connected with the Naval and Military professions, cannot be overestimated. These discussions, at a time of great scientific progress, have proved of signal value to the Public Departments of the country.

Library.

11. In making additions to this valuable branch of the Institution, the Council have exercised considerable economy during the past year, but they are of opinion, that the time has now arrived, when, with the prospect of sufficient funds, it is highly desirable that a want long felt, viz., the printing of a new Catalogue, should be supplied; and they have taken this subject into consideration in framing the estimate of expenditure for the current year.

Topographical Department.

12. Satisfactory progress has been made in arranging the valuable maps and plans in this department. This important work was most kindly commenced and carried on by Staff-Commander Bailey, R.N., to whom the best thanks of the Council are due; but much remains to be done. A Catalogue has been commenced, and the Council trust that it will be completed, as well as the improved arrangement of the department, before midsummer.

The practice of marking the positions of armies in the field, on maps in the Topographical Room, has been continued for the convenience of Members. The Council hope, by this system, to have removed some of the hindrances to a ready and careful study of military operations in the field.

Museum.

13. Several additions by presentation have been made, and thanks returned to the Donors. Some valuable additions have also been made to the specimens of defensive armour. Several models of guns

(on a uniform scale) have been added, and it is the intention of the COUNCIL to make this collection as complete as possible. It appears to be a matter of great importance that a facility for comparing the various guns should be afforded at a time when they are of so much interest. For this reason, and to supply the great deficiencies in the series of naval models, a much larger sum than usual has been appropriated for this department of the Institution. A record of the various additions will be found in the Appendix to Vol. VIII. of the Journal, as also of those to the Library and Topographical Departments.

SPECIAL GENERAL MEETING.

14. By the sanction obtained at a Special General Meeting held on Monday, May 2nd, 1864, Section II., Paragraph 1 of the Bye-laws was altered, so as to entitle the Officers of the Royal Naval Reserve to become Members without ballot. The COUNCIL are sure that the Members generally will welcome amongst them the valuable Officers of that Corps.

HONORARY MEMBERS.

15. General Todleben, of the Imperial Russian Engineers, was elected an Honorary Member, on the occasion of his recent visit to this country. Count Maffei, of the Italian Legation, has also been elected an Honorary Member.

CORRESPONDING MEMBERS.

16. At the commencement of the current year, there were 246 Corresponding Members of Council, being an increase of 64 during the past year. The COUNCIL consider it of the highest importance to the Institution, that its interests should be thus represented, amongst the various branches of Her Majesty's Naval and Military Forces. Whilst thanking the Corresponding Members for the aid already so efficiently rendered, the COUNCIL would point out that much still remains to be done to obtain that universal support which the Institution may justly claim.

CONCLUSION.

The COUNCIL have only further to observe that the advantages afforded by the Institution have now been fairly recognised, and its national importance fully established; and they are confident that the Members may look forward to a career of enlarged usefulness and increasing prosperity.

Colonel J. CLARK KENNEDY, C.B.—

My Lord Duke, and Gentlemen,—It is well known that many officers of the United Service are somewhat given to join in sundry speculations. Probably there are present on this occasion many who are connected with the various institutions and companies of the day, either as directors or as shareholders. Let us hope, for their sakes, that the companies are all limited. But those gentlemen, accustomed as they must be to their own general meetings, will, I fear, find our general meeting of to-day somewhat tame in comparison. At those meetings they find the defiant oiliness of the Directors; they find the candid Secretary, with his accounts that no one can understand; and they find the chronic growls of discontented shareholders.

Here at our general meetings nothing of the kind can occur. Our Council or Directors are here, I am sure, to receive the thanks of the whole of the members, for the manner in which they have conducted the affairs of the Institution. Our Secretary is here, with his accounts drawn out in so clear a way, that "he who runs may read;" and we understand he is here as such, and not to act as a medium between the Council and ourselves; but is also here, I trust, to receive the proper recognition due for his services to the Institution. And we as the members are here, not to growl, but to express our perfect satisfaction and our delight at the increasing prosperity of this Institution. There are one or two points to which, perhaps, I may be permitted to allude. The first is the most important of all, our financial condition. There is no necessity for my going into the figures, as they are already in every gentleman's hands. But I may draw attention specially to the point that our receipts have exceeded our estimate by upwards of £400, and that our expenditure has fallen short of our estimate by £368; thus, enabling the Council to fund a sum of £700, a sum of tenfold more importance to us now than it has been before, as we are now liable to be so far moved from a portion of the premises, that at least one half of the house will have to be rebuilt. Our financial condition has been somewhat affected by our losses and gains during the year. Our loss has been, I believe, rather more than the average. We have lost by death 100 members; 58 have retired for unavoidable reasons, but I think we may congratulate ourselves that out of nearly 4,000 members scattered over every part of the world, there are only seven gentlemen who have not paid up. Next to our financial condition, and, indeed, intimately connected with it, is the announcement which has been made this day, that the Lords of the Admiralty have agreed to share with the War Office the charge of the subsidy which we receive from Government, a subsidy which we may truly say, without any self-praise, we fairly earn from the country. In addition to the increase to our funds from the Admiralty Grant, I think we ought specially to take notice, that it is a public recognition from the Admiralty of our usefulness. With regard to the renewal of our lease, we may well leave that matter in the hands of the Council. We need be under no anxiety as to being removed from our present situation, which suits us and the public so well. However, if eventually there should be any difficulties, I think we may safely leave the matter in the hands of His Grace the First Lord of the Admiralty, and of his Lordship the Secretary of State for War. I do not think it at all likely, whatever defence the First Commissioner of Woods and Forests may make, that if he is placed between the double fire of the Army and Navy on one side, and the Admiralty and the War Office on the other, that he can possibly hold his position. We leave to those two departments their choice of guns and their choice of ammunition, without any discussion on the part of those in this room. Our *Journal*, which has taken a very prominent position in our proceedings, has this year had a more satisfactory distribution than it has ever had since the first day it was commenced. There was an estimate made last year of the sale of the *Journal*, which has been exceeded by a sum of £38, being an increase of 76 per cent. upon the original estimate. Although I dare say there are many practical minded gentlemen present who look upon that £38 as an important addition to our funds, still I have no doubt there are many others who will regard it, not as a mere sum of money, but as representing the success of the *Journal* in its increased circulation, and I trust also in its increased usefulness. With regard to the *Journal* itself, the contents of the volume for the past year has been more varied, and I may say of more value than heretofore. Almost every subject of interest to sailors and soldiers has been more or less touched upon and discussed, either in the lectures and papers which are given in this theatre, or in the communications from contributors which appear in the *Journal*. Every subject almost that you can think of connected with the services has been brought before us. From strategy to small arms, from shipbuilding to the slinging of a knapsack, from the quality of steel to the lining of a soldier's jacket, nothing has been forgotten; everything of interest to us, so far as the time would allow, has been fully and fairly discussed in the *Journal*. With regard to one of the great objects of interest of the day, The battle of the Guns, those who have been present at the various discussions here may well say that in this room the discussion has taken place with less

noise, with more knowledge than elsewhere, and with at least equal practical results. There has been one addition made to our general rules, in the admission without ballot of the officers of the Royal Naval Reserve, which was carried unanimously on a previous occasion at a Special General Meeting; still as that meeting was not of the same extent as this, I think we may take the opportunity to express our gratification at having these officers made eligible to become members of our Institution without going through the form of ballot. With regard to our library, our museum, and our professional collections, no remark from me is required; nothing can be more satisfactory than the state of the Institution generally. I am afraid I have already detained you too long; therefore, I will conclude, before moving the adoption of the Report, in the very words of the Council themselves, which should be echoed by every member of the Institution present, namely, "That the advantages afforded by the Institution have now been fairly recognised, and its national importance fully established, and they are confident that the members may look forward to a career of enlarged usefulness and of increasing prosperity." I beg to move the adoption of the Report.

Rear-Admiral OMMANNEY—

I beg to second this Resolution. The proposer has touched so fully upon the different topics in the Report, that it is unnecessary for me to say anything. The prosperity of the Institution is so apparent by the Report laid before us, that I am sure every member of this Institution will receive it with great gratification.

The Resolution was put from the Chair, and carried unanimously.

VI. The names of the eight Members retiring from the Council by rotation were read as follows:—

Captain E. PACKE.
Captain H. W. TYLER, R.E.
Commodore A. P. RYDER, R.N.
Captain M. PETRIE.
Captain W. D. MALTON.
Rear-Admiral E. G. GOLDSMITH, C.B.
Captain Sir JOHN C. D. HAY, Bart., R.N., M.P., F.R.S.
Captain J. W. TARLETON, R.N., C.B.

MONTAGU CHAMBERS, Esq., Q.C.—

My Lord Duke, and Gentlemen,—It may seem somewhat presumptuous that almost an unknown person should address so many veteran and superior officers; but obedience is the essence and strength of our United Service, and it is simply in obedience to orders that I hold in my hand a Resolution that I am quite sure will meet with the approval of all who are here present. It is a Resolution of gratitude; and gratitude is a duty that belongs not only to the United Service, but to all Englishmen who have received benefits. I will direct your attention for a few minutes, if you please, to some remarkable circumstances connected with the history and progress of this prosperous Association. It commenced with small beginnings; unostentatiously, quietly, but steadily, it has made its way; it has gradually advanced and gained strength until it has become a great national benefit. Strangers as well as subscribers derive advantages from its proceedings, and sorry am I to confess that here I myself am almost a stranger, and from my inability to attend frequently your lectures and discussions, can only acknowledge that I have been greatly benefited and instructed by receiving from time to time in the shape of your *Journals* the most interesting and important information that can be given to one who cherishes the memory of the Military Service, from the active duties of which by necessity alone, he has been compelled to retire. I think we ought all, (for although serving but a very short time, I venture to associate myself with you), to feel an honourable and just pride, that by our own exertions we have succeeded in raising our Association to its present high position, and have obtained for it, without solicitation, but by our own efforts, the recognition of the authorities as an exceedingly useful and valuable national Institution. Some passages in the Report have been particularly noticed by a preceding eloquent speaker, but it cannot but have struck

you all, that at the same time that we have been growing and increasing in strength, we have also acquired and possess "the sinews of war." Without these—I allude to financial means—it is next to impossible to succeed in any undertaking. We have set a very good example indeed, which perhaps might usefully be followed elsewhere; for it appears on looking to the estimates of probable receipts and expenditure for the past year that the expenditure has been much less, and the receipts much larger than were anticipated; so that our balance-sheet,—and I believe this has happened almost every year since we attained considerable prosperity, presents a large surplus to be devoted to savings or to future useful purposes. This is a very important matter; and certainly it does and must appear to strangers and to all who take an interest in this Institution, that its originators and those members who by their exertions have contributed to these results, are deserving of all honour for the services rendered. This has led me to enquire and to suggest by what means all this has been accomplished. By the ordinary means which will invariably ensure success, the devoted attention, the prudent assiduity, the knowledge, and experience of those to whom we have entrusted the management of our affairs. Who are they? They are the Council. I hope we shall ever recollect our obligations to the Council who have acted in former times, and that we shall now be prepared to recognise those who have served us so well during the past year, and those who are willing to act for the present as our great benefactors, and deserving of our grateful thanks. The Resolution I now propose embodies the sentiments I have endeavoured to express. It is this:—

"That the thanks of this Meeting be given to the members of the Council who retire by rotation, and that the following gentlemen be elected to fill the vacancies:—

Captain E. PACKE. Captain W. H. TYLER, R.E. Captain Sir JOHN D. HAY, Bart., R.N., M.P., F.R.S.	For Re-election.	Lieut.-Col. J. H. LE CONTEUR, Coldstream Guards. Captain R. HALL, R.N. W. F. HIGGINS, Esq.
Major A. C. COOKE, R.E.		Rear-Admiral E. G. FANSHAWE.'

Colonel DUNNE, M.P.—

My Lords and Gentlemen,—I rise with great pleasure to second the motion which has been proposed by my learned and gallant friend who sits near me. To myself—for I believe I was one of the earliest members of the Institution—it is most gratifying to see the change and advancement we have made in the prospects of this Society. I recollect when our funds were only £640 a year, and now they amount to between £3,000 and £4,000, with £4,000 in stock. But the prosperity is a great deal more apparent when you consider the usefulness of the Institution. I recollect when in the English language there was scarcely any book that a military man, wishing to improve himself in the science of his profession, could consult; we were then obliged to have recourse to French publications, and very admirable works they were too. I recollect in early life, when I first entered the Army, I formed the wish that we ourselves should be able to compete with the French in scientific attainments, and in the exposition of those attainments; and I think we have succeeded. I am happy to say that our *Journal* has improved, and is worthy of being read. I hope we shall still go on improving our works of a scientific nature in connection with military art. I am certain that publications of this kind stimulate the efforts of young men in the Army, for any man reading in the *Journal* a paper that has received praise, becomes anxious that he himself should do something; he studies his profession, and embodies the result in a paper that probably surpasses the one which first excited his emulation. I am not one of those who are so wildly mad on the subject of competitive examinations; but I do think that one of the great objects of the profession should be, that the men who embark in it should be perfectly fitted for the purpose to which they are called upon to devote their talents; and I think the lectures and discussions which are given in this Institution necessarily contribute to that desirable end. There are one or two points in the Report that I will allude

to, and to which I will call the attention of the meeting. It has always struck me that the first would be very useful in connection with the Society; the matter is now only partially carried out. I allude to sections XII and XVI, which relate to the maps and corresponding members. I do not think any country in the world should possess more geographical knowledge than Great Britain. We have our armies and our fleets scattered over the whole world; and I think every encouragement should be given to members serving abroad to send in plans of positions and geographical plans which they may have the opportunity of procuring in any part of the world. It has been done to a certain extent. I know myself, when I have been quartered in various parts of the world, that many officers with time to spare, and qualified for surveying, have formed plans which would be most valuable if received in this country. In the Depôt de la Guerre, at Paris, you will find an immense number of plans of this nature. I am perfectly certain that they are most useful, and that no country could equal ours in the collection of plans we could possess, if the suggestion I have thrown out were more generally acted upon. No doubt there would be many plans that might not be worth keeping; but the Council of this Institution, or those to whom the task might be assigned of examining them, could make a selection of those which it would be worth while to retain. At the beginning of the Crimean war I know, for I had the opportunity at the time of knowing, that very little of the ground, even round Constantinople, was known. Yet I know that there were plans in the possession of private individuals; I had some myself, which I gave to Lord Hardinge. Such as these might be procured and kept for future purposes in our Repository. I merely throw out the suggestion to the Council. It is a subject to which I have all my life turned my attention, and I simply submit it to the consideration of those who guide the administration of the Institution. That administration is in the hands of the Council, and I am certain that no gentleman present will refuse to accord to them the praise which is due for their attention, and for the condition of prosperity to which they have brought this Institution. From a low ebb, without any assistance from the Government, and without attracting any great attention from the public or the profession, they have brought the Institution to the position in which it now stands, and in which it is recognised by the Government. I do not believe that any portion of the Naval and Military Estimates voted by the House will be more usefully employed than the Grant of £600 to the Royal United Service Institution. I regret to see the names of the many members who are about to retire from the Council. That evil is corrected to a certain degree by the power of re-election. I know very well, if you can get the man who can give his time and attention to the work of the Committee, that it is most desirable to keep him. I only say I regret to see so many valuable names about to retire; I hope you will give them the praise they deserve, and I sit down by seconding the Resolution of my learned and gallant friend.

The Resolution was put from the Chair, and carried unanimously.

VII. Captain J. H. Selwyn, R.N.—

My Lord Duke, a previous speaker has said that he was perfectly ready to obey orders. I hope to show another quality which is as valuable in officers; that is, to be ready to sail at a moment's notice. I only got this Resolution put into my hand on entering this Institution, and I believe it is in consequence of the absence of the Chaplain General, who would have more fitly addressed you on the subject, that I have been called upon to move it. The Resolution refers to those gentlemen who, once a year, give us their valuable services, and who, I am happy to say, generally seem to make very short work of it, which is a very good sign of the financial state of the Institution, and also a most important sign of the clearness and accuracy with which the accounts are kept. There are some 313 working days in the year, during which there is a staff employed here to produce the fact to which the auditors give expression. A previous speaker has spoken of the candour of the Secretary as being a very good quality. I think I may add that where in addition to that candour, we find an attention to business, a courtesy and a capacity which produce such results

as those which we are now speaking of, we may say that we have got a paragon of a Secretary as well as a paragon of a Council. I do think that while we are enthusiastic about the growing prosperity of the Institution, that the labours of those gentlemen who are always here and always at work, should not be forgotten, and should receive their due acknowledgment. If the interest of the servants of the Institution is kept up by a knowledge that they share in its prosperity, I think we shall find that we have wisely employed our funds. The auditors deserve our very best thanks, and I should beg to join to them the workers who have contributed to the possibility of the auditors doing their business in so very short a time. I now beg to move the Resoution which has been put into my hands:—

"That the thanks of this Meeting be given to the Auditors for their valuable services, and that the following gentlemen be elected for the ensuing year: H. F. Downes, Esq., (re-elected), Thomas Smith Esq., Captain J. E. Dolby, and Captain J. D. Macqueen."

Vice-Admiral Sir GEORGE BACK, D.C.L., F.R S.—

I find, your Grace, that it only wants five minutes to the hour, and I think I shall be consulting the wishes of the meeting by simply seconding the motion.

The Resolution was put from the Chair, and carried unanimously.

VIII. Rear-Admiral WELLESLEY, C.B.—

My Lord Duke, and Gentlemen,—In our bye-laws I think there is an omission which I am going to propose to you to rectify. Among our list of Vice-Patrons we have the names of many high officers of state in this country, and also the name of the Lord Lieutenant of Ireland. But connected with that large portion of Her Majesty's dominions, India, we have not the name of that high Officer who is entrusted by Her Majesty with the government of that great Empire as one of our Vice-Patrons. I have therefore to propose:—

"That in Section I., paragraph 4, of the bye-laws, after the words, 'The Lord Lieutenant of Ireland" be inserted the words, 'The Viceroy and Governor General of India.'"

Major-General BOILEAU, R.E., F.R.S.—

My Lord Duke, the Resolution which has just been proposed by my friend Admiral Wellesley is based upon official considerations, therefore it does not require any remarks from me; but I venture to assure the Institution that in Sir John Lawrence, who now fills that high and distinguished position, they may calculate upon his personal interest, altogether independent of his official position; and that on every opportunity they will derive benefit from the assistance which he is able to afford.

The Resolution was put from the Chair, and carried unanimously.

IX. Lieut.-General Sir EDWARD CUST, K.C.H.—

My Lord Duke, having already occupied your time with a previous Resolution, I will be very short upon the present occasion. If that Resolution had a tone of melancholy in it, the present Resolution is one of unmixed gratification and pleasure. It is:—

"That General Lord Hotham, M.P., be elected President of this Institution."

Lord Hotham has been my oldest and most intimate friend. We have been at school together; we have shaken hands on the battle field together; we have sat in the House of Commons on the same benches together; we have kept up our intimacy to the present time, interchanging sociabilities and hospitalities. It is unnecessary for me to occupy your time with any eulogy upon his character. Moreover, his conduct in the House of Commons is known to you. You know with

what judgment and good sense he has taken up military questions; and I am sure we could not have in our Institution one who, on public and representative grounds, could be more useful to us.

Captain Sir JOHN HAY, Bart., R.N., M.P.—

I would add very little to what has fallen from Sir Edward Cust; but one or two points I think should be mentioned to this meeting with reference to the selection which the Council have put before you. The last President was a Naval Officer. The Council thought it was but right and expedient, and I, as a Naval Officer and Chairman of the Council, was only too glad to forward their view, that the second selection of President should be from the sister service. It was also thought wise that he should be a General Officer of rank, and that he should be a person who, not taking a very strong or decided part on either side in politics, should be in that position which would give him sufficient influence, not perhaps with the Admiralty or with the War Office, but with the Woods and Forests on certain occasions that might arise. Having considered this point, and having seen the particular position which Lord Hotham occupies in the Army, with the fact that he also holds an old Naval peerage, we thought there was no one else who would be more acceptable than he. It might possibly have seemed, and it did seem to some, that it would have been wiser perhaps to have first of all requested His Royal Highness at the head of the Army to have accepted the post; but it will be in the knowledge of this meeting that he is already a Vice-Patron; and it was thought better to strengthen ourselves by the addition of some one who was not a Vice-Patron of this Institution. With these few remarks I will second the motion that has been made by Sir Edward Cust.

The Resolution was put from the Chair, and carried unanimously.

The noble CHAIRMAN then announced that the business of the meeting was concluded.

The Chair was then taken by Captain Sir JOHN HAY, Bart., on the motion of Rear-Admiral Sir F. E. Nicholson, Bart., C.B., seconded by Lieutenant General Stanhope.

Sir F. NICHOLSON—

The Resolution which I have to place before the meeting is one which you will all anticipate. We have a double duty of gratitude to pay to His Grace, who has presided on this occasion. He has not only found time, amidst the onerous duties of his high office, to come and preside this afternoon, but as First Lord of the Admiralty, has given us substantial reasons for gratitude to the Board. The persons who have filled any appointment under the Board of Admiralty must be well aware how difficult it is, in the face of our growing expenditure, to get even the smallest sum for many things which we are anxious to improve. There are those dockyards that some of us have had under our charge; we have always found that many of those proposals which we, in our anxious desire to improve those establishments, have placed before the Admiralty, have had those small sums remorselessly cut out before the estimates were presented to Parliament. It therefore proves how great is the estimation in which this Institution is held by the Admiralty, that His Grace should come to preside over us on this occasion, and that we are about to receive so substantial a recognition of the services which this Institution renders by spreading the knowledge we do among the naval and military branches of the profession. I have only to move that our thanks be given to the Duke of Somerset, for presiding on this occasion.

General STANHOPE—

I do most cordially second that proposal, and I am perfectly sure, from the able manner in which it has been brought forward, that it will be accepted by you with that feeling of gratitude which I think is due to His Grace, not only for presiding

over us on this occasion, but for the active and zealous support he has always given to the Institution.

The Resolution was put from the Chair, and carried with acclamation.

His Grace the DUKE of SOMERSET—

Sir John Hay, and Gentlemen,—I am much obliged to you for the honour you have done me in this tribute of thanks. I can assure you that in acting with the Secretary of War, in the application to the Treasury for a joint grant to this Institution, I did nothing more than what I considered my duty as First Lord of the Admiralty. I am well aware, as you are also, that the position of this Institution must become more and more important. In fact, it is with this Institution as it has been with all the other Institutions in this town. Formerly, the only great scientific association was the Royal Society, but as knowledge spread and information was acquired upon different subjects, up rose the Astronomical, the Geographical, the Geological, and no end of small societies, which, as it were, branched off from the Royal Society, leaving the parent stock in order to obtain much more vigour themselves. The same want has been felt both in the Army and Navy, and it was to supply that want, very properly, that this Institution arose. If you look to the present position of the Institution, and to what it has done during the last three or four years, and see the attention which it has drawn to matters of science connected with the Army and Navy, you will see the great and growing value of this Institution. It was in that view that I recommended to the Treasury that the Admiralty and the War Office should combine to make this grant of £600 out of the estimates. I will not take up your time. I thank you sincerely for the thanks you have given me. I will only say one word with regard to the Museum. I observe that you are thinking of making a large collection of Naval models. Now, I have been a long time a trustee of the British Museum, and I know the danger of large collections. In fact our collections become so large, that we are almost pushed out of the building by them. Now, we have already got a collection of naval models at South Kensington, under the School of Naval Architecture. I would therefore humbly suggest to the Institution that they should endeavour to restrict the models that they collect here to those that are applicable to what is wanted for the day, rather than to go back and make a large collection of ancient models. The collection which is at Kensington can be seen by any member of this Institution. Her Majesty visited it the other day, and takes a great interest in it, and I have no doubt it will become very interesting as an historical collection of Naval models. At the same time a small *practical* collection with reference to the *more immediate requirements of the day* would be of great use here.

STATEMENT OF CHANGES AMONG THE MEMBERS SINCE 1ST JANUARY, 1864.

			Life.	Annual.	Total.
Number of Members, 31st December, 1863			857	2990	3847
,, ,, joined during 1864			20	195	215
			877	3185	4062
Changed from Annual to Life			+4	—4	
			881	3181	4062
	Life.	Annual.			
Deduct—Deaths during 1864	20	80			
Withdrawals		53			
Struck off		7			
			20	140	160
Numbers of Members on 1st January, 1865			861	3041	3902

Tabular Analysis of the State of the Institution, To the 31st of December, 1864.

Year 1st Jan. to 31st Dec.	Annual Subs. received.	Entrance Fees.	Income (from all sources).*	Life Subs. received.	Amount of Stock.	Invested in the purchase of Books, &c.	No. of Vols. in Library.	No. of Members on the 31st Dec.	Number of Visitors.
	£	£	£	£	£	£			
1831	654	..	654	1,194	..	..	..	1,437	..
1832	1,146	..	1,146	978	..	..	..	2,699	..
1833	1,405	..	1,450	692	..	..	..	3,341	..
1834	1,500	..	1,549	583	1,100	..	..	3,748	13,376
1835	1,480	..	1,574	366	2,430	40	..	4,155	8,537
1836	1,570	..	1,682	330	3,747	45	..	4,069	8,521
1837	1,549	..	1,747	[illegible]	4,747	180	..	4,164	10,907
1838	1,462	..	1,634	[illegible]	5,500	246	..	4,175	15,788
1839	1,399	..	1,565	168	5,500	292	..	4,186	16,248
1840	1,368	..	1,525	198	5,500	446	5,500	4,257	17,120
1841	1,450	..	1,643	186	6,000	243	5,850	4,243	19,421
1842	1,373	..	1,565	144	6,400	373	6,450	4,127	21,552
1843	1,299	..	1,494	140	6,700	237	7,000	4,078	27,056
1844	1,274	..	1,408	112	3,000	[illegible]	7,850	3,968	22,767
1845	1,313	..	1,466	228	1,500	127	8,100	3,988	21,627
1846	1,298	..	1,456	138	1,500	74	8,410	4,031	32,885
1847	1,314	74	1,502	132	1,700	37	..	4,017	38,699
1848	1,175	57	1,375	[illegible]	1,700	85	9,641	3,947	37,140
1849	1,176	72	1,375	84	1,150	[illegible]	..	3,970	33,333
1850	1,141	106	1,294	198	[illegible]	36	..	3,998	33,773
1851	1,136	131	1,292	66	[illegible]	34	10,150	3,188	52,173
[illegible]	1,134	[illegible]	1,281	114	200	43	10,300	3,078	20,609
1853	1,243	319	1,684	264	528	41	10,420	3,251	25,952
1854	1,200	138	1,368	126	612	95	10,587	3,171	22,661
[illegible]	1,159	107	1,289	120	653	55	10,780	3,131	14,778
[illegible]	1,216	197	1,519	156	761	47	10,832	3,204	16,184
1857	1,258	176	1,937	78	1,038	40	10,960	3,168	12,755
1858	1,318	221	2,102	105	438	31	11,062	3,246	25,747
1859	1,526	195	2,277	512	946	70	11,320	3,344	28,739
1860	1,961	298	3,577	397	2,178	114	11,517	3,518	28,011
1861	2,122	305	2,899	266	2,846	99	11,812	3,689	23,296
1862	2,296	242	3,127	239	3,178	109	12,026	3,797	27,215
1863	2,379	[illegible]	3,100	405	3,583	143	12,296	3,847	18,150
1864	2,425	215	3,253	222	4,516	116	12,700	3,902	17,276

* Including Annual Subscriptions, Entrance Fees, Donations, Legacies, and Interes on Funded Property; and also the Grant from Government, commencing in 1857.

DONATIONS IN 1864.

Evelyn, C. F., Capt. 3rd Royal Surrey Militia, 3*l.*
Stevens, J. H., Maj.-Gen. R.M.L.I., 1*l.*
Wilson, J. P., Lieut. late 1st Warwick Militia, 5*l.*

NAMES OF MEMBERS

WHO JOINED THE INSTITUTION BETWEEN THE 6TH JUNE AND 31ST DECEMBER, 1864.

LIFE.

Bourne, James, Lt.-Col. Comm. Roy. Lan. Art. Mil., 9*l.*
Branfill, B. A., Capt. 86th Roy. County Down, 9*l.*
Eden, A. D., Lieut. 26th Regt., 9*l.*
Gardiner, H. L., Col. Roy. Art., 6*l.*
Hall, Marshall, Lieut. Roy. East Middx. Militia, 9*l.*
Holbrook, E. N. W., Lieut. R.M.L.I., 9*l.*
Long, Samuel, Lieut. R.N., 9*l.*
Morton, J. F., Capt. 55th Regt., 9*l.*
Sandwith, F. B., Capt. 10th Regt., 9*l.*
Tanner, J. N., Lieut. 82nd Regt., 9*l.*
Vernon, *Hon.* A. H., Capt. 2nd Derby Rifle Volrs., 9*l.*
Wilson, John P., Lieut. late 1st War. Mil., 9*l.*
Young, Allen W., Lieut. Royal Naval Reserve, 9*l.*

ANNUAL.

Abercromby, *Hon.* John, Lieut. Rifle Brigade, 1*l.*
Adams, F. B., Ens. Hon. Art. Comp., 1*l.*
Agg, Wm., Lieut.-Col. 51st King's Own L.I., 1*l.*
Alcock, Nathaniel, Assist.-Surg. 35th Royal Sussex Light Inf.
Bailey, Wm., Capt. Roy. Eng., 1*l.*
Barringer, T. S., M.D., Surgeon Hon. Art. Comp., 1*l.*
Bell, John Charles, Lieut. 53rd Regt., 1*l.*
Bell, Lynden, Major Unatt., 1*l.*
Bent, H. W., Lieut. 6th Surrey Rifle Vols., 1*l.*
Boyle, R. H., Lieut. R.N., 1*l.*
Brock, J. Arthur, Capt. 82nd Regt., 1*l.*
Broderip, Edw., Ens. 57th Regt., 1*l.*
Brooke, H., Major 48th Regt., 1*l.*
Brooke, W. L., Cornet R. H. Gds., 1*l.*
Brown, R. A., Comm. R.N., 1*l.*
Burgess, Ardwick, Capt. Q.O.L.I. Mil., 1*l.*
Bythell, R., Lieut. 56th Regt.
Cadell, Thos., Lieut. Bengal Staff Corps. W.E.
Corbett, W. A., Lieut. 62nd Regt. 1*l.*
Costello, T. M., Surg. R.N., 1*l.*
Crawley, H., Lt.-Col. ret. f.p. 20th Regt.
Crawley, T. R., Lt.-Col. 6th Inniskilling Dragoons, 1*l.*
Crowe, S. M., Lieut. Kent Art. Mil.
Cuffe, O. W., Lieut. Roy. Mar. Art., 1*l.*
Cumming, W. Gordon, Major Bombay Staff Corps.
Dando, A. C., Lt. Roy. Nav. Reserve, 1*l.*
Davenport, W. B., Capt. 62nd Regt., 1*l.*
Dickenson, P. M., Lieut. Roy. Sussex L.I. Mil., 1*l.*
Drummond, John, Lieut. late 10th Hus., 1*l.*
Dudgeon, R. C., Major 61st Regt., 1*l.*
Eglese, Joseph, Capt. Hon. Art. Co., 1*l.*
Ellison, R. G., Major h.p. 47th Regt., 1*l.*
Evans, John, Capt. 6th Inniskilling Drs., 1*l.*
Foster, J. F., Ens. Ceylon Rifles.
Fulton, J. J., Capt. Mad. Staff Corps.
Gipps, H., Capt. 9th Regt.
Goodliffe, F. G., Lieut. London Rifle Brig. Volrs., 1*l.*
Grant, Wm., Lieut. 91st Highlanders.
Gratton, A. O. D., Lt.-Col. Roy. Eng., 1*l.*
Haig, C. T., Capt. Roy Eng., 1*l.*
Hall, E. C., Capt. R.N., 1*l.*
Herbert, Arthur, Col. unatt., 1*l.*
Hutton, C. W., Capt. 59th Regt., 1*l.*
James, J. W., Comm. R.N., 1*l.*
Jones, G. P. R., Capt. Q.O.L.I. Mil.
Kain, Geo. James, Capt. 1st Middlesex Eng.-Volrs., 1*l.*
Kennedy, J. J., Ens. 10th Regt.

Kidston, A. F., Lieut. 42nd Royal Highlanders, 1*l.*
Knight, H. S., Capt. 19th Regt., 1*l.*
Lee, J. E., Lieut. 55th Regt., 1*l.*
McDiarmid, H. C., Lieut. Roy. Eng., 1*l.*
MacGauran, F., Esq., Clerk, War Office.
Martin, Edw., Lieut. late 28th Mad. N.I., 1*l.*
Mayo, W. R., Esq., Dep.-Assist. Sup. of Stores, 1*l.*
Newgent, St. G. M., Major unatt. Assist.-Quartermaster General.
Newton, C. E., Major Derbyshire Rifle Vols., 1*l.*
Ouchterlony, T. H., Lieut. Roy. Art.
Panter, H. G., Major 1st W.I. Regt., 1*l.*
Pennethorne, L. P., Lieut. Roy. Art., 1*l.*
Pollard, Charles, Capt. Roy. Engineers (Bengal), 1*l.*
Pollard, H. W., Lieut. 67th Regt.
Power, W. J., Cornet 6th Inniskilling Drs., 1*l.*
Pullen, W. J. S., Capt. R.N., 1*l.*
Pulleyne, E. Lieut. 18th Hussars, 1*l.*
Ross, W. H., Capt. 23rd Bombay N.I.
Sawyer, G. W., Ens. 8th or King's.
Seton, W. C., Lieut. 82nd Regt., 1*l.*
Sherbrooke, W., Lieut. R.N., 1*l.*
Soady, F. J., Maj. Roy. Art., 1*l.*
Spence, J., Ens. 67th Regt., 1*l.*
Stewart, W. Houston, C.B., Capt. R.N., 1*l.*
Stirling, Francis, Lieut. R.N., 1*l.*
Stokes, Alfred, Lieut. 38th Regt., 1*l.*
Taylor, Rev. H. A., M.A., Chaplain to the Forces.
Tolson, W., Lieut. 35th Roy. Sussex L. I., 1*l.*
Tompson, W. D., Capt. 17th Regt., 1*l.*
Vander-Meulen, J. H., Lt. 50th Regt., 1*l.*
Voyle, G. E., Lt.-Col. Roy. Art., 1*l.*
Wahab, Geo. D., Lieut. 20th Regt., 1*l.*
Walker, A., Lieut. 79th Highrs., 1*l.*
Watson, D., Col. 82nd Regt., 1*l.*
Weatherley, F. A., Capt. 6th Inniskilling Drs. 1*l.*
Wilson, W. H., Ens., 7th Roy. Fus.
Wingfield, W., Dep. Assist. Commissary Gen., 1*l.*

ADDITIONS TO THE LIBRARY AND MUSEUM DURING 1864.

LIBRARY.

BOOKS PRESENTED.

AIDE-MEMOIRE. A L'Usage des Officiers d'Artillerie. Troisième Edition. 8°. Paris, 1856.

Dictionnaire de la Gendarmerie. 2nd Edition. 12°. Paris, 1838.

——— 2nd Edition. 12°. Paris, 1844. *Major-General Sir Alex. Tulloch, K.C.B.*

ANNALES HYDROGRAPHIQUES. No. 377. 1er Trimestre de 1864. 8°. Paris. *M. Le Ministre de la Marine et des Colonies.*

ANNUARIO Ufficiale dell Esercito Italiano 1864. Anno decimo. 1 Vol. 8°. Turin, 1864.

Annuario dell Italia Militare per il 1864. Anno primo. 1 Vol. Turin, 1864. *The Italian Government.*

Annuaire de la Marine et des Colonies. Paris, 1864. *La Direction de la Revue Maritime et Coloniale.*

ANSTRUTHER, P., Major-General late Madras Artillery. The Flight of Projectiles. Pamp. 8vo. London, 1864. 2 copies. *The Author.*

ARCHIVES of the Prussian Artillery and Engineers for 1861-62-63. 3 Vols. *The Prussian Government.*

ASTRONOMICAL, Magnetical, and Meteorological Observations made at Greenwich in the year 1862. Folio. 1864. *The Lords Commissioners of the Admiralty.*

BALFOUR, E., Dep.-Inspec. Gen. of Hosps. The Timber Trees, Timber and Fancy Woods, as also the Forests of India and Eastern and Southern Asia. 1 Vol. 8vo. Madras, 1862. 2nd Edition. *The Author.*

BLUE BOOKS:

Hudson's Bay Company. An Address of the House of Lords, dated 2nd July, 1863, for Copies of Correspondence between the Colonial Office and Hudson's Bay Company, since 1st January, 1862, relative to a road and telegraph to British Columbia—the transfer of the rights of Hudson's Bay Company to other parties.

Correspondence respecting the construction of a Telegraph line through Persia. 1 Vol. Folio. March 18, 1864.

Further Papers relating to Military Operations on the Gold Coast. 1 Vol. Folio. June, 1864. Plan to ditto.

North America. Correspondence respecting the Enlistment of British subjects in the United States Army. Folio. June 9, 1864.

Ashantee War. Copies or Extracts of any Despatches relating to. Folio. June 21, 1864.

Greenwich Hospital Return to an Order of the House of Lords, dated 16th June, 1864. Copy of the Memorandum on Greenwich Hospital. By the Duke of Somerset. Folio. June 16, 1864.

Army (India) Return, pursuant to an Address of the House of Lords, for Copies of the Despatch to the Government of India, dated 17th June, 1864. No. 194, informing them of the steps taken by Her Majesty's Government consequent on the report of the Commissioner appointed to inquire into the alleged departure from the Parliamentary guarantee to Officers of Indian Armies. Folio. June 25, 1864.

BLUE BOOKS, *continued.*

Report of Her Majesty's Commissioners appointed to inquire into the High Court of Admiralty in Ireland. 1 Vol. Folio. 1864.

Further Papers relative to the recent disturbances in New Zealand. 1 Vol. Folio. 1862.

Report on the Realisation and Distribution of Army Prize by Commissioners appointed to inquire. 1 Vol. Folio. 1864.

Correspondence respecting the fitting out, dispatching to China, and ultimate withdrawal, of the Anglo-Chinese Fleet.

Report of a Committee appointed to consider the claims of Captain Grant. Folio. London, 1864.

Papers relating to the proposal that Parliament should guarantee a Loan to be received by the Government of New Zealand to meet the expenses arising out of the Native War. 1 Vol. Folio. 1864.

North American Correspondence respecting Recruiting in Ireland.

Two Papers relating to the War in New Zealand. March 3, 1864. July, 1864. 2 Vols. Folio.

Reports. Colonial Possessions for the year 1861. Folio. 1863. Part II.

Returns. Wrecks and Casualties on the Coast of the United Kingdom from 1st January to 31st December, 1862. Folio. 1863.

Journal and detailed Reports relative to the Exploration of British North America, by Captain Palliser, during the years 1857-58-59 and 1860. Folio. 1863.

Further Papers relative to the affairs of New Zealand. 2 Vols. Folio. 1863 and 1864.

Report of the Ordnance Survey and Topographical Depôt to December 31, 1863. 1 Vol. Folio. 1864.

Royal Commission on the Sanitary State of the Army of India. 2 Vols. Folio. London, 1863.

Report on Ventilation of Cavalry Stables. Folio. London, 1864.

Report of the Commissioners appointed to inquire into the Sanitary State of the Army in India, with Precis of Evidence. 1 Vol. 8vo. London, 1863. *W. F. Higgins, Esq.*

Return, Navy Labour Chart, Navy Estimates for 1864-65. *Anonymously.*

BLUE BOOKS, *continued.*

Return, Malta New Dock. Folio. 1863. *Anonymously.*

Portsmouth Dockyard Extension, with plans. Folio. 1864. *Anonymously.*

Report, Patent Office, Library, and Museum. 1 Vol. Folio. July 19, 1864.

Second Report on Dockyards. 1 Vol. Folio. July 15, 1864.

Navy. Ships Annual Account of Expenses incurred on Her Majesty's Ships—Building, Converting, Repairing, and Fitting, &c., during the financial year 1863-64. 1 Vol. Folio. July 22, 1864. *Anonymously.*

Ordnance Report. Folio. 1863. *Colonel French, M.P.*

Statement of the Savings and Deficiencies upon the grants for Navy Services in the year ending 31st March, 1863. *Major L. White.*

Report of the Barrack and Hospital Commission on the Sanitary Condition and Improvement of the Mediterranean Stations. Folio. London, 1863. *Secretary of State for War.*

Statistical Return of the Health of the Royal Navy 1859-60. 2 Vols. 8vo. 1862-63.

Army Medical Department. Statistical, Sanitary, and Medical Reports, 1861. 1 Vol. 8vo. 1863.

Report from the Select Committee of the House of Lords, appointed to inquire how far it may be practicable to offer better shelter for Shipping upon our Coast. 1 Vol. Folio. August 13, 1860.

Report, Naval Promotion and Retirement. 1 Vol. Folio. 1863.

Report of the Commission on the Memorials of Indian Officers. Folio. 1864.

Return, Timber in Dockyards. 1 Vol. Folio. 1863. *Colonel Dunne, M.P.*

BOYER, A. History of the Reign of Queen Anne. 1 Vol. Folio. 1735. *Sergeant Stephen Fiest, Sco. Fus. Gds.*

BUDGET des Dépenses de l'Exercice 1865. 1 Vol. 4°. Paris, 1864. *M. Le Ministre de la Marine et des Colonies.*

CARDIGAN, Lieut.-General the Right Hon. the Earl of, K.C.B. The Cavalry Brigade Movements. 1 Vol. Small 4to. London, 1861. *The Author.*

CATALOGUE, Topographical Depôt, St. Petersburgh, 1 Vol.
The Russian Government.

——— War Office Library. 1 Vol. 8vo. London, 1864.
The Secretary of State for War.

CUST, Lieut.-Gen. Hon. Sir Edward K.C.H., &c. Annals of the Wars of the 19th Century. Vols. III. and IV. 8vo. London, 1863.
The Author.

DAVIS, W. Catalogue of Minerals in the Museum of the Royal Artillery Institution, Woolwich. 2 Copies.
Six Pamphlets on Geology.
J. Tennant, F.G.S.

DRACH, S. M., F.R.A.S. On the Circle-Area, and Heptagon-Chord. Pamp. 8vo. *The Author.*

DUNCAN, F., Lieut. R.A. Our Garrisons in the West; or, Sketches in British North America. 8vo. London, 1864.
The Author.

EDWARDS, M. Milne. Sur de nouvelles observations de MM. Lartet et Christy relatives à l'existence de l'homme dans le centre de la France à une époque où cette contrée était habitée par le Renne et d'autres animaux qui n'y vivent pas de nos jours. Extrait des comptes rendus des séances de l'Académie des Sciences. Tome LVIII. Pamp. Folio.
H. Christy, Esq.

ELLIS, B. E., Captain R.A. Our Artillery as proposed to be Re-modelled. Pamp. 8vo. London, 1864.

EVOLUTION Squadron under the command of Vice-Admiral Lord Hood, Principal position of the Summer of 1792. Folio. MSS.
Rear-Admiral J. J. Stopford.

FOX, C. R., Lieut.-General. Engravings of unpublished or rare Greek Coins. Part I. Europe. Part II. Asia and Africa. 4to. London. *The Author.*

GIORNALE del Genio Militare. Anno 1. 1863. 22 Parts. 38 Plates. With Index. 8vo. Turin.
Giornale di Artiglieria. Publicato d'Ordine del Ministero della Guerra, 1861-1863. 8vo. Turin.
Operazioni dell Artiglieria negli assedi di Gaëta e Messina negli anni 1860 e 1861. 1 Vol. Roy. 8vo. Turin. 1864.
Relazione sulle Leve Esequito in Italia delle annessioni delle varie Provincie al 30th September, 1863. 1 Vol. 4to. Turin, 1864.
Tabella Generale delle Stanze Del Corpi, 1864.
The Italian Government.

GREENFIELD, H. Our Future Navy: its Tactics, and how to Construct it. Pamp. 8vo. London, 1863. *The Author.*

HALSTED, Rear-Admiral. England's Navy Unarmed. A Series of Letters to the First Lord of the Admiralty, and in "The Daily News." Pamp. 8vo. London, 1864. 10 Copies.

——— 2nd Edition. With Addenda. *The Author.*

HESSE-DARMSTADT, Grand Duchy of. Military Instructions from 1862 to 1864. 13 Parts.
Major F. Schole, Librarian, War Department, Darmstadt.

HINTS on National Defence, on matters connected with Art and other Subjects. Pamp. 8vo. London, 1864.
Anonymously.

HODGE, W. B. A Paper on Shipwrecks in the Royal Navy. Pamp. 8vo. London, 1864. *The Author.*

INSTRUCTIONS, Additional, for the Ships of War. 1 Vol. sm. 4to. 1799.
Rear-Admiral J. J. Stopford.

INTERNATIONAL Exhibition, 1862. Reports by the Juries on the Subjects in the 36 Classes into which the Exhibition was divided. Imp. 8vo. London, 1863.
H. M. Commissioners of the International Exhibition of 1862.

KONGL: Krigs Vetenskaps-Akademiens. Handlingar och Tidskrift. 3 Vols. 1861-62-63. 8vo. Stockholm.
The Swedish Government.

La Charité sur les Champs de Bataille, suites des Résultats de la Conférence Internationale de Genève. Genève. 1864.

LE CONGRÈS et le Traité de Genève. Pamp. Août, 1864.
Le Congrès de Genève. Rapport addressé au Conseil Fédéral.
Mons. Henrie Dunant.

LEFROY, J. H., Brigadier-General R.A. F.R.S. Official Catalogue of the Museum of Artillery in the Rotunda, Woolwich. Pamp. 8vo. London, 1864.
The Author.

LENDY, Capt. A. F., F.G.S., &c. A Practical Course of Military Surveying including the Principles of Topographical Drawing. 1 Vol. 4to. London, 1864. *The Author.*

MAGNETICAL and Meteorological Obser-

vations made at the Government Observatory, Bombay, 1861. Folio. Bombay, 1862.
Secretary of State for India

MARTIN, Major, 4th King's Own. Pilgrim Nuisance. Pamp. 3 Copies.
Specification of a Cinerator for the use of Brahmins and other Hindoo Castes who perform their Funeral Rites by Burning. Pamp. 8vo. Bombay.
The Author.

MEMOIRS of the Topographical Depôt, St. Petersburgh. 3 Vols.
The Russian War Department.

MILLER, Major F., R.A., U.C. Gun Cotton. An Introduction to the Properties and History of the Substance.
The Author.
Equipment of Artillery, compiled by. 1 Vol. 8vo. London, 1864.
The Secretary of State for War.

NAVAL Officer. A Few Remarks on Naval Promotion by a. Pamp. 8vo. London, 1864. *Anonymously.*

NEWSPAPERS:
1793, Miscellaneous from November to December. 1 Vol.
1794, from January to December. 1 Vol.
1795, from January to December, 1 Vol.
1795, "True Briton" from January to June. 1 Vol.
1796, "True Briton" from July to December. 1 Vol.
1796, "Morning Chronicle" and "Oracle" from January to December. 2 Vols.
1800, various from January to December. 1 Vol.
1801, various from January to December. 1 Vol.
1802, various from January to December. 1 Vol.
1806, various from January to December. 1 Vol.
1807, various from January to December. 1 Vol.
1808, various from January to December. 1 Vol.
1809, various from January to December. 1 Vol.
1810, various from January to December. 1 Vol.
W. F. Higgins, Esq.

PETRIE, M., Captain 14th Regt. Topo. Staff. Army of Great Britain. 1864-65. 2nd Edition. London, 1864.
The Secretary of State for War.

REDDIE, Jas. Slavery. Small Pamp.
The Author.

REPORT on the Federal Swiss Army, by Colonel J. L. A. Simmons, C.B., Royal Engineers.
The Secretary of State for War.

REVUE Maritime et Coloniale. 14 Numbers. 1864. Paris. 8vo.
La Direction de la Marine et des Colonies.

ROBINSON, John, B.A. and M.B. An Easy Mode of ascertaining the Capabilities of Soil, &c. New addition. Pamp. 8vo. London, 1863. *The Author.*

ROYAL ENGINEERS. Professional Papers of the Corps of. Vol. XIII. 8vo. 1864. New Series. *The Editor.*

ROYAL ENGINEER ESTABLISHMENT:
Lecture 6. The Principles of Mechanics, by Lieut. Fraser, R.E.
Vol. III., Paper II. On the Mouths of the Danube, and Improvement of the Mouths of Rivers in non-Tidal Seas, by Major Stokes, R.E.
Paper VII. On the Causes of Deviation of Projectiles unconnected with Rifling, by Lieut. Richardson, R.E. 2 Copies.
Paper IX. Principles of Reserved Defences, by Colonel Graham, R.E.
The Establishment.

ROYAL SOCIETY, the President's Address at the Anniversary Meeting of, 30th November, 1863. 8vo. London, 1863.
Application of Gun-Cotton to Warlike Purposes. Report. Pamp. 8vo. London, 1863.
Maj.-Gen. E. Sabine, R.A., D.C.L., &c.

RULES and Regulations of the Corps of Commissionaires. 2 Copies.
The Founder, Captain Walter.

RUSSIAN Military Journal. 12 Numbers for 1863, 1 Number for 1864.
The Russian Government.

RUSSIAN Military Journal. 6 Numbers.
Colonel Novitzky.

SAMUDA, J. D'A. On the Form and Materials of Iron-Plated Ships. With Discussion. Pamp. 8vo. London, 1864. *The Author.*

SANITARY Commission of the United States Army. Succinct Narrative of its Works and Purposes. 1 Vol. 8vo. 1864.
Statement of the Objects and Methods of the Sanitary Commission, No. 69. Pamp. 8vo. 1864.
The United States Sanitary Commission. Small Pamp. 8vo. Boston,

1864. Military, Medical, and Surgical Essays. 1 Vol. 8vo. 1864.
United States Sanitary Commission (English Branch).

SCIENTIFIC American, the. A Weekly Journal of Practical Information in Art, Science, Mechanics, Chemistry, and Manufactures. 1 Number.
A. H. Dillon, Esq., Ensign Rifle Brig.

SCOTT, R. A. E., Comm. R.N. On the Principles of Construction and Armament of Iron-Clads. Pamp. 4to. 1864.
The Author.

SHIP-BUILDING, Theoretical and Practical, Parts I.–V. Folio.
Mr. W. Mackenzie.

SIGNAL BOOK for the Ships of War. 1 Vol. 4to. London, 1808.
Rear-Admiral J. J. Stopford.

SMYTH, W. H., Vice-Admiral, K.S.F., D.C.L., &c. Addenda to Ædes Hartwellianæ. Folio. London.
The Author.

TENNANT, Sir James Emerson. The Story of the Guns. 8vo. London, 1864.
The Author.

THE RIFLE CONFERENCE of 1864. Report of Proceedings. With Additional Papers and Drawings and an Index. 8vo. London, 1864.
Captain J. MacGrigor.

UNITED SERVICE Club. Alphabetical List of Members, with the Rules and Regulations.
The Secretary of the Club.

WALKER, A., Esq., Lieut. 79th Highs., School of Musketry, Hythe. The Rifle: its Theory and Practice. 8vo. London, 1864. *The Author.*

WALKER, J. Description of New Vessel and Mode of Working Guns, with Plan. 7 Copies. *The Author.*

WEST INDIES, Action in, during the late War, by an Officer of the Royal Navy who was present. 1 Vol. 4to. Chester, 1784. *Rear-Admiral J. J. Stopford.*

JOURNALS AND TRANSACTIONS.

INSTITUTIONS.

ASSOCIATION—THE BRITISH. Index to Reports and Transactions from 1831 to 1860, for the Advancement of Science. 1 Vol 8vo. London, 1864.

Report of the 33rd Meeting of the British Association for the Advancement of Science, held at Newcastle-upon-Tyne in August and September, 1863. 1 Vol 8vo. 1864.
The Association.

MECHANICAL ENGINEERS, Proceedings of, 4th and 5th August, 1863. Parts II. and III.

5th November, 1863.
28th January, 1864.
5th May, 1864. *The Institution.*

NAVAL ARCHITECTS, Transactions of. Vol IV. 4to. 1863. *The Institution.*

ROYAL ARTILLERY, Proceedings of. Vol III., No. 16. Vol IV., Nos. 2 to 8. 1864. *The Institution.*

ROYAL, of Great Britain, Proceedings of. Parts III. and IV. of Vol IV.

Weekly Evening Meeting, Friday, 15th April, 1864. Chemical History and Application of Gun-Cotton. By Professor Abel, F.R.S.
The Institution.

ROYAL LIFE BOAT, Journal of. Nos. 51—54 of Vol V. *The Institution.*

UNITED SERVICE OF WESTERN INDIA. Confucius, the Sage of China: being the subject of a Lecture delivered at the above Institution on the 14th October, 1863, by M. Haug, Phil.D. 3 copies. Small 8vo. Poona, 1863.
The Institution.

SOCIETIES.

ANTIQUARIES, Proceedings of. Vol II., No. 5. *The Society.*

ARTS, JOURNAL. Vol XII. Nos. 580 to 632 of Vol XIII. *The Society.*

ART-UNION of London, Almanac. 3 copies.

Annual Report and List of Members.
The Society.

ROYAL AGRICULTURAL, Journal. Parts I. and II. of Vol XXV.
The Society.

ROYAL ASIATIC, Journal. Parts III. and IV. of Vol XX. Part I. of Vol I. New Series. *The Society.*

ROYAL ASTRONOMICAL, Memoirs of. Vol XXXII., for the Session of 1862-3.
The Society.

ROYAL ASTRONOMICAL, of Edinburgh. Astronomical Observations for 1855—59. Vol XII.

Report read by the Astronomer Royal for Scotland to the Special Meeting of Her Majesty's Government Board of Visitors. Small Pamp., 4to. 1864.

ROYAL GEOGRAPHICAL, Proceedings. Vol VIII. Nos. 1—6.
Journal. Vol XXXIII. 1863.
Report of the Council at the Annual General Meeting, April 29th, 1864.
Report of the Accounts of the Auditors appointed 21st January, 1864.
The Society.

THE ROYAL, Proceedings. Nos. 60 to 69 of Vol XIII. *The Society.*

ROYAL NAVAL SCRIPTURE READERS. Occasional Papers. 10 copies.

ZOOLOGICAL SOCIETY (of London), Proceedings. Parts I., II., and III. of 1863.
Transactions. Part III. of Vol V.
Report of the Council read at the Annual General Meeting, 29th April, 1864.
Report of the Accounts of the Auditors appointed, 21st January, 1864.
The Society.

BOOKS PURCHASED.

ALCOCK, Sir Rutherford, K.C.B. Narrative of a Three Years' Residence in Japan. 2 Vols, 8vo. London, 1863.

BARRY, P. The Dockyards, Shipyards, and Marine of France. 1 Vol, 8vo. London, 1864.

DOCKYARD Economy and Naval Power. 1 Vol, 8vo. London, 1863.

BAY, Christian Frederick. Engelsk Dansk Ordbog. 2 Vols, 8vo. Copenhagen, 1806.

BONNEFOUX, Baron de. Dictionnaire de Marine à Voiles et à Vapeur. 2 Vols, large 8vo. Paris, 2nd edition.

BOUTAKOV, Grégoire, Rear-Admiral Imp. Russian Service. Nouvelles Bases de Tactique Navale. 1 Vol, 8vo. Paris, 1864. Translated from Russian into French.

BOXER, E. M., Captain Royal Artillery. Treatise on Artillery. 1 Vol, 8vo. London, 1860. Two diagrams to do.

——— Chapter on Congreve Rockets. Pamp., 8vo. London, 1860.

BURKE's Landed Gentry of Great Britain and Ireland. 1 Vol, large 8vo. London, 1863.

CMESNEY, G. Observation on the Amalgamation of the Regiments of Royal and Indian Artillery and Engineers. Pamp., 8vo. London, 1861.

CUNNINGHAM, J. D., Captain Indian Army. A History of the Sikhs from the Origin of the Nation to the Battles of the Sutlej, wiih Map. 1 Vol, 8vo. London, 1849.

DAUMAS, E., Général de Division, &c. The Horses of the Sahara and the Manners of the Desert. Translated from the French. 1 Vol, 8vo. London, 1863.

ENGINEERS, Architects, and Contractors' Pocket-Book. 1 Vol, small 8vo. London, 1864.

ERSKINE, John Elphinstone, Captain R.A. Journal of a Cruise among the Islands of the Western Pacific. 1 Vol, 8vo. 1853.

EYRE, Edward John. Journals and Expeditions of Discovery into Central Australia in the Years 1840-1. 2 Vols, 8vo. London, 1845.

FEZENZAC, M. le Duc de. Souvenirs Militaires de 1804—14. 1 Vol, 8vo. Paris, 1863.

HAKLUYT SOCIETY. Report for 1863. 1 Vol, 8vo. London, 1863.

——— The Travels of Ludovico di Varthema A.D. 1503—08. 1 Vol, 8vo. London, 1864.

——— The Travels of Cieza de Leon in 1554. 1 Vol, 8vo. London, 1864.

HALLECK, H., Major-Gen. U.S.A. Elements of Military Arts and Science, &c., &c. 1 Vol, 8vo. 3rd Ed. New York, 1862.

HOLLEY, Alexander L., B.P. A Treatise on Ordnance and Armour. 1 Vol, 8vo. New York, 1865.

INDEX GEOGRAPHICUS, being a List, Alphabetically arranged of the Principal Places on the Globe, computed specially with reference to Keith Johnson's Atlas. 1 Vol, 8vo. London, 1864.

JUKES, J. Beete, M.A., F.G.S. Narrative of the Surveying Voyage of H.M.S. "Fly." 2 Vols, 8vo. London, 1847.

KAYE, John William. A History of the Sepoy War in India, 1857-1858. 1 Vol, 8vo. London, 1864.

KYNASTON, A. F., Lieut. R.N. Casualties Afloat, with Practical Suggestions for their Prevention and Remedy. 1 Vol, 8vo. London, 1849.

LABOULAYE, Ch. Annales du Conservatoire. Nos. 15 and 16. 1864.

LAFAY, J., Capitaine d'Artillerie de Marine. Aide-Mémoire d' Artillerie Navale. 1 Vol, 8vo. Paris, 1850.

LANGLEY, Edward Archer, late Captain Madras Cavalry. Narrative of a Residence at the Court of Meer Ali Moorad; with Wild Sports in the Valley of the Indus. 2 Vols, 8vo. London, 1860.

LE ROUGE, Le Sieur, Ingénieur Géographe du Roi. Journal du Camp de Compiègne de 1739. 1 Vol. Paris, 1761.

MACDOUGALL, Lt.-Colonel P. L. Modern Warfare as Influenced by Modern Artillery. 1 Vol, 8vo. London, 1864.

MARTIN, Frederick. The Statesman Year Book for the Year 1865. 1 Vol, 8vo. London, 1865.

MARTIN, R. M. The Hudson Bay Territories and Vancovers Island. 1 Vol, 8vo. London, 1849.

MILITAIR Conversations-Lexikon. Edited by H. E. W. Von der Lüke. 8 vols, 8vo. Leipzig, 1838.

MURRAY, Arch. K. History of the Scottish Regiments in the British Army. 1 Vol, 8vo. Glasgow, 1862.

NAPOLEON 1ER, Correspondence de. Vols XIV., XV., and XVI. 8vo. Paris, 1863-64.

PARIS, M., le Contre-Amiral. Supplément à l'Art Naval à l'Exposition Universelle de 1862. 8vo. Paris.

PARKES, Edmd. A., M.D., F.R.S. A Manual of Practical Hygiene, prepared especially for use in the Medical Service of the Army. 1 Vol, 8vo. London, 1864.

PERCY, John, M.D., F.R.S. Metallurgy, the Art of Extracting Metals from their Ores, and adapting them to various purposes of Manufacture, Iron and Steel. 1 Vol, 8vo.. London, 1864.

PERRY, M. C., Comr. U. S. Navy. Narrative of an Expedition of an American Squadron to the China Seas and Japan, in the Years 1852, '53, and '54. 1 Vol. New York, 1857.

QUEEN'S Regulations and Admiralty Instructions, Addenda to. 1 Vol, folio. 1864.

RANKINE, W. J. R., C.E. A Manual of Applied Mechanics. 1 Vol, 8vo. London, 1864.

REPORT of our Commissioner on Coast Defences. 2 Vols, 8vo. Washington, 1862.

RODMAN, T. J., Captain of the Ordnance Department, U.S. Army. Reports of Experiments on the Properties of Metals for Cannon and the Qualities of Cannon Powder. 1 Vol, 4to. Boston, 1861.

ROEMER, J., LL.D., late Officer of Cavalry, Netherlands. Cavalry: its History, Management, and Uses in War. 1 Vol, 8vo. New York, 1863.

RÜSTOW, Cæsar. Die Kriegshandfeuerwaffen. 2 Vols. Berlin, 1857 and 1864.

SECOURS aux Blessés. Communication du Comité International faisant suite au compte rendu de la Conférence Internationale de Genève. 1 Vol, 8vo. Genève, 1864.

STURT, Charles, Captain, F.L.S., F.R.G.S. Narrative of an Expedition into Central Australia. 2 Vols, 8vo. London, 1849.

TODLEBEN, Lieut.-Général, E. de. Défense de Sébastopol. Vol 1, Parts 1 and 2, 4°. St. Petersburg, 1863. Atlas to Ditto. Elephant Folio.

TREDGOLD, Thomas. Practical Essay on the Strength of Cast-Iron and other Metals. 2 Vols, 8vo. London, 1862.

WELLINGTON, Arthur, Duke of, K.G. Supplementary Despatches. Vol XI., 8vo. 1864.

WHEATON, Henry, LL.D. Elements of International Law. 1 Vol, 8vo. 1864.

WOLFFE, Ernest. Dictionary—Danish and English. 1 Vol, 4to. London, 1779.

WRIGHT, Robert. The Life of Major-General James Wolfe. 1 Vol, 8vo. London, 1864.

YONGE, C. D. The History of the British Navy from the Earliest Period to the Present Time. 2 Vols, 8vo. London, 1863.

PERIODICALS PURCHASED.

Allen's Indian Mail.
Annual Register.
Army and Navy Gazette.
Army List, Hart's.
Army List Monthly.
Artizan.
Athenæum.
Civil Engineer.
Edinburgh Review.
Engineer.
Gentleman's Magazine.
Herald, New York.
Journal, Edinburgh New Philosophical.
Journal des Armes Spéciales.
Journal des Services Militaires.
Journal, Spectateur Militaire.
Journal, United Service.
Mechanics' Magazine.
Nautical Magazine.
Naval and Military Gazette.
Navy List, Quarterly.
Notes and Queries.
Quarterly Review.
The Times.
Westminster Review.
Year-Book of Facts.

MAPS, PLANS, CHARTS, SKETCHES, &c.

Map of the Island of Alsen in Denmark. 2 Copies.

Two Maps Illustrating the late Action in New Zealand. 2 Copies.

Plan of the District around Shanghae under the protection of the Allied Forces. 1862-63. 2 Copies.

Map of Jutland. 2 Copies.

Sketch of the Fortress of Fredericia and its neighbourhood, Jutland. 2 Copies.

Map, in two sheets, of the neighbourhood of the Waikato River, New Zealand.

Map of Virginia, showing the Lines of Operations of the Federal and Confederate Armies. 2nd Edition. 2 Copies.

Map of the Port of the Northern Island of New Zealand, showing the Scale of the Military Operations of 1863-4. 2 Copies.

The Secretary of State for War.

Maps (American):

1. Mountain Region of North Carolina and Tennessee.
2. State of Virginia.
3. Charleston Harbour and its Approaches, showing the Positions of the Rebel Batteries. *U. S. Coast Survey.*
4. Southern Mississippi and Alabama, showing the Approaches to Mobile.
5. Battle Field of Chattanooga, with the Operations of the National Forces under the command of Major-General U. S. Grant, during the 23rd, 24th, and 25th November, 1863.
6. Plan of Fort Jackson, showing the Effects of the Bombardment by the Mortar Flotilla, from the 18th to 24th April, 1862.
7. Plan of the Reconnoissance of the Mississippi River below Fort Jackson and St. Philip.
8. Plans and Views of Rebel Defences, Coast of South Carolina.

Captain G. Goodenough, RN.

Map of Canada West, Mounted and Varnished, with Case.

Maj.-Gen. Crutchley.

Plan of Malta. Valetta Harbour—Proposed Docks.

Capt. E. Gardiner Fishbourne, R.N., C.B.

Thirteen Charts Published between August, 1863, and August, 1864.

The Lords Commissioners of the Admiralty.

Sketch of a Hammock, the Invention of Captain McGwers, 1st Royals.

John Wilson Smith, Esq., Ensign 1st Royal Regt. of Foot.

Photographs, Sixty-six (Mounted), of Guns.

Four ditto of Captain Grant's Cooking Apparatus.

Ditto 11-inch Blakely Gun.

Ditto Oblique Front.

Ditto Oblique Rear.

Photograph 9-inch Blakely Gun.
Ditto Oblique Front.
Ditto Oblique Rear.
Ditto Wagon Boiler.
Ditto Pontoon.
Ditto Pontoon Raft.
Ditto Boiler, ready for Cooking. } Grant's Cooking Apparatus.

One ditto Whitworth 1-pounder Rifled Gun. 2 Copies.

Two ditto Manby's Life Preserving Apparatus. Colonel Boxer's ditto.

Five ditto 12-pounder Armstrong Gun for Competition Trial.

One ditto Captain Keys, R.N., Plan of Securing Shell.

Ditto, ditto Whitworth 12-pounder, Gun for Competition.

Ditto, ditto Armstrong 12-pounder Shunt Gun, with Projectiles.

Ditto, ditto Special Sheers for Mounting Heavy Guns.

Secretary of State for War.

Photographs on Glass of Missing Atlantic Steamers—U. S. M. SS. Pacific, SS. City of Glasgow, S. President, ditto when last seen. *C. B. Sharpe, Esq.*

Photograph of Long's Breech-Loader.

Colonel Abel Cortwell.

Oil Pictures Framed :—

1. Sea Beach.
2. Steep Holmes and Shipping.
3. Teignmouth Harbour and Shipping.
4. Dartmouth Harbour.
5. Boat Landing—a Fog Piece.
6. Portsmouth Harbour.

Bequeathed by the late Captain M. Montague, R.N.

Caudwell's Patent Floating Battery, Drawing Framed and Glazed.

Presented by the Designer.

An Old Bible. Originally the Property of the famous John Balfour, of Burley, who tore out the first part of it to load his musket at the Battle of Drumclog.

The Lady Alice Hay.

Two Autographs, one of Lord Nelson and one of the Earl St. Vincent.

Captain Lambert, R.N.

Sketch of Captain Whitty's, Breech-loading Gun, Designed in 1832.

By the Inventor.

Design of the Monument Erected by the Officers of the 53rd Regiment to the Memory of the Officers of that Corps who were killed and died by exposure during the Indian Mutiny.

Mr. Geo. Felstead.

MUSEUM.

MILITARY.

Uniform, Arms, and Accoutrements of one of the Scinde Irregular Horse.

Capt. G. W. Macauley, Commt. 1st Scinde Horse.

Officer's Schako, 56th Regt., worn by Mr. Lee in 1814.

Officer's Sword Belt. *F. R. Lee, Esq.*

One Persian Artillery Sword.

One ditto Native ditto.

Two Native Swords (one with Portuguese blade).

2 Persian Breastplates.

Capt. Kettlewell, H.M. Bombay Staff Corps.

Bow and Arrows taken from a dead Tartar, in 1860, at the Capture of the Taku Forts.

Commander R. A. Brown, R.N.

Chinese Flag from the Taku Forts.

W. F. Higgins, Esq.

Poisoned Arrow. Obsidian Head made and used by the Apaches and Comanches, wild tribes of Mexican Indians.

Captain A. C. Tupper.

Ashantee Ammunition Pouch.

Lieut. Fred. Blacklin, 4th W. I. Regt.

Model of American Whale-Boat used in the Sea of Okhotsk, North of Tartary.

Comm. R. A. Brown, R.N.

Turkish Arrow used at the Siege of Rhodes. Given by the Turkish Governor to C. Newton, Esq., in October, 1863, and by him to Lieut.-Gen. Fox.

Lieut.-Gen. C. R. Fox.

Gun which belonged to, and was much used by, the celebrated Rebel Brazilian

General-in-Chief, Don Pedro Ivo, in 1848-9, who for a long time kept the Brazilian Troops on the *qui vive*.

Presented by
Capt. Wm. Persse Newenham, R.N.

Gun-Stock made by Machinery in 1849, the same as that now Employed at Enfield for Making Gun Stocks.

Messrs. Wilkinson and Son.

Models of a Camel Battery 9-pounder Gun, Carriage, and Camels, which Battery was formerly attached to the Joudpore Legion.

Lt.-Col. J. F. Hale, H.M. Indian Forces.

Hydraulic-Drawn Steel Tubes.

Tube Drawing and Steel Ordnance Co.

Model (¼-size) of Horsfall Gun (Smooth-Bore) with Carriage.

The Directors of the Mersey Steel and Ironworks.

Camp Hospital Dhoolee or Stretcher.

Capt. G. Russell, R.N.

ARMS PURCHASED:—

A small double Cannon, said to have been found at Deptford.

A Chain Suit of Mail, each link stamped up with inscriptions in Arabic, from the Koran.

A Saracenic Suit, consisting of circular and other plates, with Chain Mail, from the Armoury of Constantinople.

A Saracenic Helmet, from do.

A Chain Suit of Mail and Plates ornamented with brass.

MODELS PURCHASED:—

15-inch Gun, American } ¼-size.
10 „ „ }
8 „ „ }

600-Pounder Shunt Shot, full-size.

Sectional Model of 7-inch Shunt Gun and Shot.

MISCELLANEOUS.

Writing Box, originally the Property of Sir John Moore, containing a Manuscript Book in which Sir Robert Gardiner copied several Orders issued by, or relating to, Sir John Moore. Also a Letter from Sir John Moore, written a few days before his death.

Bequeathed by General
Sir Robert Gardiner, R.A., G.C.B.

Bullets used during the Siege of Sebastopol.

Key taken from a Church in Sebastopol.

Russian Soldiers' Reel for Silk and Needles.

Russian Knife and Spoon from Inkerman.

Granite from Sebastopol.

Ditto from Castle Rock, Balaclava.

W. Bent, Esq.

A Milner or Peltier Electrometer.

Made and Presented to the Institution by Captain J. H. Selwyn, R.N.

Sample of Iron Sand from Taranaki, New Zealand.

Four Specimens of Steel made from ditto. *Messrs. Moseley and Son.*

NAVAL.

MODELS.

Model of a Full-Rigged Tripod Mast Cupola Ship. *Capt. C. P. Coles, R.N.*

Model of a Plan for Working the Heaviest Ordnance on board Armour-Plated Ships. *Capt. Edward Inglefield, R.N., F.R.S.*

Model of the Russian Cargo Boats used at their Settlement at the Alentian Islands, made of the Hide of the Walrus and sewn together. The boat of which this is a Model holds 3½ tons of cargo, or Fur Seal skins.

Model of a Whaling and Fishing Canoe used by the Natives of the Alentian Islands. *Comm. J. W. Pike, R.N.*

MISCELLANEOUS.

MODELS.

The Dirk of Lord Nelson when a Midshipman. *J. E. Forster, Esq.*

Pointer Board for Pointing Ships' Guns.

Training Pendulum.

Training Level, as invented and patented by *Commander B. Sharpe, R.N.*

Five-bladed Cutlass for Boarding, invented by the donor.
Mr. Henry Duke.

Iron Shot, obtained from a fisherman, who hauled it up in his dredging net from the bottom of the sea in Sole Bay (now called Southwold Bay); a relic of the great fight which took place there on the 28th May, 1672, when the English and French fleets, commanded by the Duke of Yorke, afterwards James the Second, and Marshal d'Etrees, defeated the Dutch under the celebrated De Ruyter.
Mr. Lode.

Naval Officers' Sword of 1716.

Leader for Coupled Rockets, invented and presented by
Lieut. W. Harris, R.N.

Specimen of Allan's Indestructible Deep-Sea Telegraph Cable for a distance of 1,500 miles and depth of 2,500 fathoms.
Do. do. for a distance of 2,000 miles and depth of 2,500 fathoms.
Allan, Esq., C.E.

Submarine Recovery Buoy.
E. Templemore, Esq.

Sundry Relics from the Royal George.
W. Barclay Hutchinson, Esq.

LIST OF MEMBERS

OF THE

ROYAL UNITED SERVICE INSTITUTION,

CORRECTED TO THE

1ST JANUARY, 1865.

WHITEHALL YARD, LONDON.
[MARCH, 1865.]

Officers wishing to become Members of the Royal United Service Institution may fill up one of the subjoined forms,—tear out the leaf and inclose it to the Secretary:—

FORM FOR BECOMING AN ANNUAL SUBSCRIBER.

_____186

IT is my desire to become a Member of the Royal United Service Institution; and I hereby request and authorise my Agents [or Bankers], Messrs. _____, to pay my Entrance Fee and Annual Subscription now, and as it becomes due on the 1st January in each year, to the Secretary of the Institution.

_____Signature.

_____Qualification for Membership.

FORM FOR BECOMING A LIFE SUBSCRIBER.

IT is my desire to become a Life Member of the Royal United Service Institution; and I hereby authorise my Agents [or Bankers], Messrs. _____, to pay my Entrance Fee and Life Subscription to the Secretary of the Institution.

_____Signature.

_____Qualification for Membership.

Entrance Fee—ONE POUND.

Annual Subscription—ONE POUND, which entitles a Member to receive the Journal; or TEN SHILLINGS without the Journal.

Life Subscription TEN POUNDS (including Entrance Fee), which entitles a Member to receive the Journal, or SIX POUNDS (in addition to the Entrance Fee) without the Journal.

Officers in India may pay their Subscriptions to Messrs. Gillander and Co., Calcutta; Messrs. Arbuthnot and Co., Madras; or Messrs. Remington and Co., Bombay.

LIST OF ANNUAL SUBSCRIBERS.

* *Denotes Corresponding Member of Council.*

*ABADIE, H. R. Lieut. 17th Lancers (1*l.*)
Abbey, R. Major late 72nd Regt. (1*l.*)
Abbott, *Sir* F. CB. Maj.-Gen. (ret.) Beng. Engs. Member of Coun. of Mil. Edu. (1*l.*)
Abercromby, *Hon.* John Lieut. Rifle Brigade (1*l.*)
Abercromby, R. W. D. Lieut. R.N. (1*l.*)
Abinger, LORD W. F. Lieut.-Col. S. F. Gds.
Ackers, G. H. Lieut.-Col. Staffd. Yeo. Cav. late Lieut. R. H. Gds. (1*l.*)
*Acland, T. Dyke Lt.-Col. 1st Dev. Rifle Volunteers (1*l.*)
Adair, Alex. W. Capt. (ret.) 52nd Light Inf. (1*l.*)
Adair, James Major late unatt. (1*l.*)
Adair, J. W. D. Major unatt. (1*l.*)
*Adair, R. A. Shafto Col. Suffolk Mil. Artillery, *ADC. to the Queen* (1*l.*)
*Adams, Cadwallader Col. 49th Regt. (1*l.*)
Adams, C. Maj. Instr. Mil. Hist. R. M. Coll. (1*l.*)
Adams, E. Col. Sec. R. M. Asylum (1*l.*)
Adams, Fred. Lieut. H. M. Bom. Staff Corps (1*l.*)
Adams, F. B. Ens. Hon. Art. Co. (1*l.*)
Adams, John Rear Admiral
Adams, W. H. Col. late unatt. Prof. of Fortification at the R. M. Acad. Sandhurst (1*l.*)
Adderley, Mylles B. B. Capt. R. H. Gds.
Addington, *Hon.* Leonard A. Capt. R.A.
Addison, J. E. Col. h.p. 97th Regt. Member of the Council of Mil. Education (1*l.* 1*s.*)
*Addison, T. CB. Col. 2nd Q. Roy. Regt. (1*l.*)
Adye, John M. CB. Col. Roy. Art. Dep. Adj.-Gen. East Indies (1*l.*)
Agg, T. F. Capt. (ret.) 16th Lancers (1*l.*)
Agg, Wm. Lieut.-Col. 51st K.O.L.I. (1*l.*)
Agnew, C. Major late 11th Regt. (1*l.*)
Ainslie, C. P. Maj. Gen. late 14th Drs.
Ainslie, Henry F. Col. (ret.) 83rd Regt. (1*l.* 1*s.*)
Airey, J. M. C. Lieut. R.N. (1*l.*)
Airey, *Sir* Rich. KCB. Lt.-Gen. Col. 17th Regt. Qua.-Mas.-Gen. (1*l.*)
Aitchison, *Sir* John, KCB. Gen. Col. 72nd Regt. (1*l.*).
Aitchison, W. Lt.-Col. Sco. Fus. Gds.
Albermarle, G. T. EARL of Maj.-Gen.
Alcock, Nathaniel, Asst.-Surg. 35th Roy. Sussex Regiment
Alcock Thomas late Capt. 1st Dr. Gds. M.P.
Aldridge, R. Capt. late 60th Roy. Rifles
Aldworth, R. W. Col. (ret.) 7th Roy. Fus. (1*l.*)
Alexander, Claud Lieut.-Col. Gren. Gds. (1*l.*)
Alexander, James, Major.General H.M. Indian Army
Alexander, *Sir* J. E. Colonel (ret. h. p.) (1*l.*
Allardice, G. J. C. Ens. 50th Regt. (1*l.*)
Allaway, W. A. Lt. Roy. Monm. Lt. Inf. Mil. (1*l.*)
Allen, E. M. Lieut. 21st R.N.B. Fus.
Alston, A. H. Comr. R.N. (1*l.*)
Alston, W. E. M.D. Staff Assist-Sur. (1*l.*)
Ames, H. M. Cornet late Glouc. Yeo.
Ames, Lionel Lt.-Col. late Herts. Mil. (1*l.*)
Amiel, F. J. T. Lieut. late 73rd Regt. (1*l.*).
Amsinck, William Major late 53rd Foot
Anderson, A. M.D. Insp. Gen. of Hosps. (1*l.*)
Anderson, David Lieut.Col. 22nd Regt.
Anderson, George Dep. Insp. Gen. of Hospls. (1*l.*)
Anderson, Thomas Surgeon, h.p. 3rd Foot (1*l.*)
Anderson, Thos. E. Capt. Unatt. (1*l.*)
Anderson, W. CB. Col. (ret.) Beng. Art. (1*l.*)
Anderson, Wm. Cochrane Maj.-Gen R.H.A.
Anderson, W. F. Capt. H.M. 11th Bom. N.I. (1*l.*)
Anderton, W. I. Capt. Lanc. Hus. late 17th Lancers
Andrews, Wm. Geo. Major R.A. (1*l.*)
Angelo, E.A. KH. KW. Col. late 30th Foot (1*l.*)
Angelo, J. A. Capt. R.A.
Angerstein, John Julius W. Lieut.-Gen. (1*l.*)
Annesley, *Hon.* Arthur Capt. (ret.) Rifle Brigade
Anstruther, P. R. Lieut. 94th Regt.
Anstruther, Philip, CB. Maj.-Gen. late Madras Art. (1*l.*)
Anstruther, Robt. Lt.-Col. (ret.) Gren. Gds. (1*l.*)
Arbuckle, B. H. Vaughan Maj.-Gen. (ret.) R.A. (1*l.*)
Arbuthnott, *Hon. Sir* Hugh, KCB. Gen. Col. 79th Highlanders, M.P.
Arbuthnott, H. T. Major R.A. (1*l.*)
Archdall, Mervyn Capt. late 6th Drs. MP.
Archer, D. Col. late 30th Beng. Europeans (1*l.*)
Archer, W. H. Major late 16th Lancers
Arkwright, A. P. Comr. R.N. (1*l.*)
Arkwright, Ferd W. Capt. 2nd Derby Mil. late 4th Dr. Gds. (1*l.*)
*Armistead, *Rev.* C. J. M.A. Chap. R.N. (1*l.*)
Armstrong, C. Major 35th Roy. Sus. Regt.
Armstrong, C. A. Capt. 10th Regt. (1*l.*)
*Armstrong, E. Capt. 23rd R. W. Fusiliers

Armstrong, J. W. CB. Col. unatt. Assist. Adj.-General, Aldershot (1*l.*)
Armstrong, *Sir* W. Geo. CB. late Engineer the War Dep. for rifled Ordnance (1*l.*)
Armytage, H. Lt.-Col. Colds. Gds.
Arthur, Thos. Lt.-Col. late 3rd Drag. Gds.
Arthur, W. Stevens Capt. R.N. (1*l.*)
Arthur, Wm. Comr. R.N. (1*l.*)
Ashby, Geo. Ashby Capt. late 11th Hussars
*Ashley, LORD Lt.-Col. Dorset Mil. MP. (1*l.*)
Askwith, W. Harrison Col. R.A. Sup. Gunpowder Factory, Waltham Abbey
Astley, J. Dugdale Lt.-Col. late Sco. Fus. Gds.
*Atcherley, W. A. Lieut. 84th Regt. (1*l.*)
Atchison, T. Lt.-Col. R. Lanc. Mil. Art. late R.A. (1*l.*)
Atkinson, John Capt. Qua.-Master h.p. late Gr. Grds. (1*l.*)
Atkinson, R. H. Ens. 14th Regt. (1*l.*)
Atkinson, T. G. B. Capt. 94th Regt.
Atkinson, Thos. Lieut. 63rd Regt.
Auchmuty, *Sir* Sam. Benj., G.C.B. General, Col. 7th Royal Fusiliers
Aufrere, Geo. Capt. late 20th Light Dns. (1*l.* 1*s.*)
Austen, *Sir* Francis W., GCB. Admiral of the Fleet (1*l.*)
Austin, E. F. Capt. Royal Hospital, Chelsea
Austin, Horatio T. CB. Rear-Adm. (1*l.*)
Aylmer, J. E. F. Lieut. 8th or King's
Aytoun, Jas. Capt. 85th Lt. Infy. (1*l.*)

BELGIANS, HIS MAJESTY THE KING OF, KG. GCB. Field Marshal (2*l.*)
Back, *Sir* George, DCL. FRS. Vice-Adm. (1*l*)
Bacon, H. Commander R.N. (1*l.*)
Bailey, Lucius C. Staff Commander R.N. (1*l.*)
Bailey, William Capt. R. E. (1*l.*)
Baillie, Duncan J. Capt. R. H. Gds. (1*l.*)
Baillie, George Clement Lt.-Col. R.E.
Baillie, Hugh Col. late Surrey Rangers
Baillie, Hugh S. Col. R.H. Gds.
Baillie, J. Capt. late 26th Bengal N.I. and Lt.-Col. late Turkish Service (1*l.* 1*s.*)
Bain George Dep.-Asst. Com.-Gen.
Baird, Alex. Paym. 2nd Queen's (1*l.*)
Baker, Francis B. Assist. Surg. Sco. Fus. Gds.
Baker, Francis C. R. Lieut. R.N. (1*l.*)
*Baker, T. D. Capt. 18th Royal Irish (1*l*).
Baker, T. R. Major late 7th Fusiliers (1*l*).
*Baker, Valentine Lt.-Col. 10th Huss. (1*l*).
Baker, W. E. Col. R.E. Bengal (1*l*).
Baker, W. T. Capt. 12th Regt.
*Balcombe, James Capt. and Adj. S. Down Mil. (1*l*).
Balders, C. W. M. CB. Major Gen. (1*l*).
Baldwin, Charles F. Lieut. R.E. Bombay
Baldwin, F. C. Lieut. Ceylon Rifles
Baldwin, G. W. Major 20th Regt. (1*l.*)
*Balfour, C. John Comr. R.N. (1*l*).
Balfour, H. L. Capt. R.A. (1*l.*)
Balfour, T. G. M.D. Dep. Insp. Gen. of Hosps.
*Balguy, C. Y. Capt. Derby Mil. (1*l.*)
Ballard, John Arch. C.B. Lieut.-Col. R.E. Bombay (1*l.*)
Ballen, Geo. Qua.-Mast. Hon. Art. Co. (1*l.*)
Banister, Thomas Capt. late 15th Regt.
Banks, Chas. Esq., late Asst. Sec. Roy. Hosp. Kilmainham (1*l.*)
Bannister, C. W. Maj. (ret.) 2d Bom. L. Cav. (1*l.*)
Baring, Charles Lt.-Col. Cold. Gds.
Baring, Denzil H. Capt. Cold. Gds. (1*l*).
Baring, Francis Lt.-Col. Scots. Fus. Gds.
*Barker, G. D. Major 64th Regt. (1*l.*)
Barker, John Lieut. West Essex Mil. (1*l.*)
Barker, John B. Capt. 75th Regt. (1*l.*)
Barker, W. J. Lieut. Roy. Marine L. I. (1*l.*)
Barlow, Henry W. Capt. late R.E.
Barlow, Maurice Maj.-Gen., Col. 3rd W.I. Regt.
Barnard, W. A. M. Lieut.-Col. 96th Regt.
Barne, F. St. John N. Capt. Sco. Fus. Gds. (1*l.*)
Barnes, C. H. Surgeon late H.E.I.C.S.
Barnes, C. H. Capt. Royal Horse Art.
Barnett, Edward Rear-Adm. (1*l.*)
Barrett, Saml. Lieut. 3rd Huss. (1*l.*)
Barringer, T. S. M.D. Surg. Hon. Art. Co. (1*l.*)
Barron, Fenwick Boyce Lt.-Col. (ret.) 3rd Dr. Gds.
Barron, N. J. Lieut. 5th Fus.
Barrow, John, Esq. FRS. late Admrlty. (1*l.*)
Barry, Philip Major-General R.E.
Barstow, Geo. Lieut.-Col. R.A. (1*l.*)
Basden, Charles Rear-Adm.
Bassano, Philip H. Esq. War Office
Bassett, W. W. Capt. 56th Regt. (1*l.*)
Bastard, Baldwin J.P. Lieut. late 9th Regt.
Bastard, J. Stokes Major-Gen. (ret.) R.A.
Bates, Henry Major-Gen. 98th Regt. (1*l.*)
Bateson, Rich. H. Capt. 1st Life Gds.
Bathurst, F. T. A.H. Lt.-Col. Gren. Gds. (1*l.*)
Bathurst, Henry Lt.-Col. late Sco. Fus. Gds.
Batley, William Surg. Roy. Sussex L. I. Mil. late Staff Assist.-Surgeon
*Battersby, J. P. Capt. 3rd Batt. 60th Roy. Rifles
Battersby, Rt. Dep. Insp. Gen. of Army Hosps.
Battine, W. A. Capt. 16th Lancers
Battiscombe, W. B. Major 91st Regt. (1*l.*)
*Baxter, Stafford Squire Capt. 1st Warwick Mil. (1*l.*)
Bayley, C. J. Esq. late Gov. of the Bahamas (1*l.*)
Bayley, George Major, Staff-officer of Pensioners, Limerick
Baylis, Edw. Esq. Dep.-Lt. Middlesex (1*l.*)
Bayly, Vere T. Capt. 54th Regt. (15*s.*)
Baynes, Geo. E. Major 8th or King's (1*l.*)
Baynes, R. S. Lt.-Col. Dep. A. A. Gen. (1*l.*)
Baynes, *Sir* R. L. KCB. Vice-Admiral (1*l.*)
Bazalgette, S. A. Capt. Royal Art. (1*l.*)
Beadnell, H. C. T. Lieut. 63rd Regt. (1*l.*)
Beale, L. Esq. late Staff Surgeon
Beale, P. Capt. 10th Regt. (1*l.*)
Beames, P. T. Lieut. 11th Regt. (1*l.*)
Beamish, H. H. Commander R.N.

Beauchamp, T. W. B. P. Maj. late Suffolk Mil. Capt. Norfolk Rifle Vols.
Beaumont, G. W. Capt. Sco. Fus. Gds. (1*l.*)
Beaumont, R. H. J. B. Colonel unatt. (1*l.*)
Becher, A. B. Capt. R.N. Hydro. Office Admiralty
Beckwith, W. KH. Lieut.-Gen. Col. 14th Hussars
Bedford, R. T. Capt. R.N.
Belfield, Edward Capt. R.E. Assist. Inspec. Gen. of Fortifications
Bell, J. C. Lieut. 58rd Regt. (1*l.*)
Bell, Richd. Capt. late Hon. Art. Comp. (1*l.*)
Bell, Lynden Major unatt. (1*l.*)
Bell, W. Lieut. 56th Regt. (1*l.*)
*Bell, W. H. M.D. Asst.-Surg. R.N. (1*l.*)
*Bell, W. M. Major 3rd Huss. (1*l.* 1*s.*)
*Bellamy, P. L. Capt. 55th Regt.
Bellers, R. B. Capt. & Adj. Wilts. Mil. (1*l.*)
Belson, Fred. Capt. late Rifle Brigade
Bennet, P. Lieut. (ret.) R. H. Gds.
Bennett, Thos. Vice-Admiral (1*l.*)
Bennitt, W. W. Lieut. 6th Inns. Drags. (1*l.*)
Bent, Charles Lieut. R.A.
Bent, H. W. Lieut. 6th Surrey Art. Vols. (1*l.*)
*Bent, W. H. Capt. R. East Mid. Mil. (1*l.*)
Bentinck, A. Cavendish Col. (h.p. ret.) (1*l.*)
Bentinck, *Sir* H. J. W. KCB. Lieut.-Gen. Col. 28th Regt. (1*l.*)
Benyon, W. H. Lieut. 23rd R. W. Fus. (1*l.*)
Beresford, D. W. Pack, late R.A. M.P. (1*l.*)
Beresford, E. M. Capt. Sco. Fus. Gds. (1*l.*)
Beresford, G. R. Capt. h.p. 7th Fus. (1*l.*)
Beresford, Rt. Hon. William late Major (1*l.*)
Berger, Ernest A. Capt. 10th Regt. (1*l.*)
Berkeley, R. W. Staff Asst.-Surg. Colchester
*Bertram, C. P. Bt. Major 41st Regt. (1*l.*)
Berwick, LORD Col. late Salop Rifle Vols.
Best, G. H. Capt. (ret.) 51st King's Own L.I.
Best, M. G. Major (ret.) 25th Regt. (1*l.*)
Best, *Hon.* R. R. Capt. late Gren. Gds. (1*l.*)
Best, Thomas Capt. late Hampshire Mil. (1*l.*)
Bethune, C. R. Drinkwater, CB. Vice.-Adm. (1*l.*)
Bewes, W. E. Col. School of Musky. (1*l.*)
Biddulph, R. M. Lieut. (ret.) 1st Life Gds.
Biddulph, *Sir* T. M. KCB. Col. unatt.
Biden, John (1*l.*)
*Bigge, T. S. Major 5th Fus. (1*l.*)
Bigge, W. M. Lieut.-Col. Northum. L. I. Mil. (1*l.*)
Biggs, James Paymaster R. N.
Billington, G. M. Capt. 6th Inns. Drags. (1*l.*)
Bingham, A. B. Capt. late 11th Hussars
Bingham, Geo. LORD Lt.-Col. (ret.) Cold. Gds.
Binney, C. R. Capt. R.E. Instr. in Survg. Roy. Mil. Academy Woolwich (1*l.*)
Birch, Thomas F. Capt. R.N. (1*l.*)
*Birch, W. B. Lieut. H.M. 15th Beng. Cav.
Bird, Edward J. Rear-Adm. (1*l.*)
Bishop, E. W. Lieut. late 22nd Regt. (1*l.*)
Black, G. R. S. Capt. 60th Roy. Rifles (1*l.*)
Black, Wilsone Capt. 6th Regt. (1*l.*)
Blackburne, J. Ireland Lt.-Col. 4th Roy. Lanc. Mil. (1*l.*)
Blackett, C. E. Lt.-Col. Colds. Guards (1*l.*)
Blackett, E. W. Major 7th Dep. Battn.
Blagrave, John Colonel Roy. Berks Militia
Blair, D. H. Lt.-Col. (ret) Sco. Fus. Gds. (1*l.*)
Blair, J. Capt. R.A. Madras (1*l.*)
Blair, Jas. B. Lieut. 6th Regt.
Blair, Stopford Col. h.p. Roy. Art. (1*l.*)
Blake, Edgar H. Lieut. R.N.
Blake, G. F. Capt. Royal Marine L. I. (1*l.*)
Blake-Humfrey, T. Ens. 8th or King's
Blake, Patrick John Rear-Adm. (1*l.*)
Blakeney, *Right Hon. Sir* Edward, GCB. GCH. Fd. Mars. Col. 1st Rls. Gov. Chels. Hosp. (1*l.*)
Blamire, Charles Major 99th Regt. (1*l.*)
Blandford, G. C. MARQUIS of Cornet R.H. Gds. (1*l.*)
Blanford, Thos. Lieut. Lond. Rifle Brig. Vols. (1*l.*)
Blane, C. G. Capt. 23rd Roy. Welch Fus.
Blane, Robert, C.B. Col. unatt. Assist. Adj.-Gen. Dublin (1*l.*)
Blane, Seymour J. Lt.-Col. 52nd L.I. Mil. Secy. Bengal
Blantyre, C. W. LORD Lieut. late Gr. Gds.
Blayney, C. D. LORD Capt. late 80th Regt.
*Blewitt, Charles Capt. 65th Regt. (1*l.*)
Blockley, John Capt. Hon. Art. Comp. (1*l.*)
Blois, William Col. (ret.) 52nd Regt.
Blomfield, H. J. Capt. R.N.
Blood, Bindon Lieut. R. E. (1*l.*)
Bloomfield, Hy. Keane Maj.-Gen. Comg. the Forces, Cork
Bloomfield, John Maj.-Gen. R.A. (1*l.*)
Blowers, W. H. Capt. H.M. Bem. Staff Corps (1*l.*)
Blundell, Richd. Capt. 3rd Huss. (1*l.*)
Blyth, W. d'Urban Capt. (ret.) 14th Huss. (1*l.*)
Blythe, J. D. Capt. Paymr. (ret.) h.p. 45th Regt.
Boghurst, Edward Lieut. h.p. R.A.
Boileau, A. Lt.-Col. Roy. Engs. Mad. (1*l.*)
Boileau, J. T. Major-Gen. (ret.) Bengal Eng. (1*l.*)
Boland, R. S. Capt. late 59th Regt.
Boldero, H. G. Lt.-Col. late 38th Regt. M.P.
Boldero, G.N. Lieut.-Col. 22nd Depôt Batt.
Bolton, F. J. Capt. 12th Regt. (1*l.*)
Bond, John Capt. 93rd Highlanders (1*l.*)
Bonham-Carter, H. Capt. Colds. Gds. (1*l.*)
Boom, A. S. Ens. late 15th Regt. (1*l.*)
Booth, Robert Assist. Com. Gen.
Borough, *Sir* Edw. *Bt.* Dep.-Lieut. Co. Dublin
Bosanquet, C. J. Capt. R.N.
*Bosanquet, G. S. Comr. R.N. (1*l.*)
Bostock, J. A. Surg.-Maj. Sco. Fus. Gds. (1*l.*)
Boteler, J. H. Capt. R.N.
Boucherett, H. R. Capt. late 17th Lancers
Boulcott, J. W. Lieut. 86th Regt. (1*l.*)
Bourchier, Claude T. V. C. Lieut.-Colonel Rifle Brigade
Bousfield, Henry Surg. (ret.) Bengal Army
Bouverie, Everard W. Lieut.-Gen. Col. 15th Hussars (1*l.*)
Bowden, H. Capt. late Sco. Fus. Gds.
Bowden, H. G. Major (ret.) 22nd Regt. (1*l.*)

Bowden, H. G. Capt. Scots Fus. Gds. (1*l.*)
Bowdoin, Jas. Temple Capt. late 4th Drag. Gds. (1*l.*)
Bowers, E. R. S. late Major
Bowers, Henry Dep. Comr.-General
Bowles, *Sir* George, KCB. Lt.-Gen. Col. 1st W.I.R. Lt. Gov. Tower (1*l.*)
Bowles, R. F. Capt. late Roy. Berks. Mil. (1*l.*)
Bowles, *Sir* William, KCB. Admiral (1*l.*)
Bowly, J. A. Lieut. R.E. (1*l.*)
Bowyer, Edward Capt. late 1st W. I. Regt.
Bowyer, H. A. Capt. (ret.) 10th Huss.
Boxer, E. M. Lt.-Col. Royal Art. Supt. Rl. Laby. Woolwich (1*l.*)
Boyce, A. W. Capt. 34th Regt. (1*l.*)
Boyce, J. Lieut. (ret.) 16th Regt. (1*l.*)
Boycott, E. E. D. Capt. 14th Huss.
Boyd, A. Major late 11th Regt. (1*l.*)
Boyd, Jas. P. Lieut. 63rd Regt. (1*l.*)
Boyle, Alexr. Capt. R.N. (1*l.*)
Boyle, Gerald E. Lieut. Rifle Brig. (1*l.*)
Boyle, R. H. Lieut. R.N. (1*l.*)
Boyle, *Hon.* W. G. Lt.-Col. Colds. Gds.
Boys, Edward Capt. R.N.
Boys, Henry Capt. late unatt.
Brabant, Edw. Yewd Lieut. Cape Mtd. Rifles
Bracken, R. D. C. Capt. 2nd Sikh Inf. (1*l.*)
Brackenbury, C.B. Capt. R.A. Lt. of Comy. Roy. Mil. Academy, Woolwich (1*l.*)
Bradford, Ralph Lt.-Col. (ret.) Gr. Gds.
Bradford, Wilmot H. Col. h.p. Roy. Canad. Rifles.
Bramston, Thos. H. Lt.-Col. Gr. Gds.
Brand, H. R. Capt. Colds. Gds. (1*l.*)
Brandling, Charles Lieut. late Gren. Gds.
Brandreth, F. Lt.-Col. late R. Cumb. Mil.
Bravo, A. Capt. 1st W. I. Regt.
Braybrooke, S. Maj.-Gen. unatt.
Breen, H. Hagert, Esq. late Administrator Government St. Lucia (1*l.*)
Brent, H. W. Lieut. R. N. (1*l.*)
Brett, John Davy Major late 17th Lan. Lt.-Col. Norfolk Rifle Volunteers
Brickdale, J. F. Capt. late W. Som. Yeo.
Bridge, Cyprian Col. (ret.) 58th Regt.
Bridges, E. S. Capt. Gr. Gds. (1*l.*)
Bridges, W. W. S. Commr. R.N. (1*l.*)
Bridgman, J. W. Major W. Mid. R. Vols. (1*l.*)
Brien, C. R. MD. Dep. Insp. Gen. R.N. (1*l.*)
Briggs, John, FRS. Gen. H.M. Madras Army (1*l.*)
Bringhurst, J. H. Major late 90th Regt.
Brisley, W. P. Capt. and Paym. R.A. (1*l.*)
Brock, J. Athol Capt. 82nd Regt. (1*l.*)
Brock, Thomas S. CB. Capt. R.N.
Brockman, Charles, Esq. late Paym.-Genls. Office (1*l.*)
Broderip, Edm. Ens. 57th Regt. (1*l.*)
Bromley, *Sir* R. M. KCB. late Acct.-Gen. R.N. (1*l.*)
Brooke, E. B. Major-Gen. comg. Troops in *the Leeward* and Windward Islands (1*l.*)
Brooke, E. T. Major R.E. (1*l.*)
Brooke, H. Bt.-Major 48th Regt. (1*l.*)
Brooke, W. L. Cornet Roy. Horse Gds. (1*l.*)
Brotherton, *Sir* T. W. GCB. Gen. Col. 1st Drag. Gds. (1*l.*)
Brough, Richard Lieut. Paym. h.p. 83rd Regt.
Broughton, W. E. D. Col. R.E. (1*l.*)
Browell, Langton Commr. R.N.
Brown, Fred. Lieut. 3rd Royal Sur. Mil. (1*l.*)
Brown, J. H. Lieut. R.N. Reserve (1*l.*)
Brown, *Rt. Hon. Sir* Geo. GCB. KH. Gen. Col. Rifle Brig. Com. the Forces, Ireland
Brown, C. B. Lieut. 8th or King's
Brown, H. C. N. Capt. 2nd W. York L. I.
Brown, Henry Col. (ret.) H.M. Indian Army (1*l.*)
Brown, R. A. Comr. R.N. (1*l.*)
Brown, Thomas Chief Engineer R.N. (1*l.*)
Browne, C. A. G. Major 4th Huss. (1*l.*)
Browne, W. P. Lieut. 7th Royal Fus. (1*l.*)
Brownlow, *Hon.* Edwd. Capt. late Sco. Fus. Gds.
Brownrigg, Studholme, CB. Col. h.p. unatt. (1*l.*)
Bruce, A. C. Capt. 91st Highlanders.
Bruce, Lord Chas. W.B. Capt. 1st Life Gds. (1*l.*)
Bruce, Edw. J. Capt. R.A.
Bruce, G. B. Lieut. late 14th Huss. (1*l.*)
Bruce, Michael Col. Gren. Gds.
Bruce, Robert Col. (ret.) 2nd Queen's Royals (1*l.*)
Bruce, R. C. Dalrymple Capt. h.p. 8th Regt. Staff Officer of Pensioners (1*l.*)
Brunell, William Maj. Paym. 25th Regt.
Bruyeres, Henry Pringle Lieut. h.p. R.E.
Buchanan, J. R. G. Lieut. 26th Regt. (1*l.*)
Buckingham and Chandos, Duke of, KG. Colonel Royal Bucks Yeo. (1*l.*)
Buckland, F. T. Asst.-Surg. late 2nd Life Gds. (1*l.*)
Buckle, C. H. M. CB. Rear-Adm. (1*l.*)
Budd, Ralph Col. 14th Regt. (1*l.*)
*Bulger, G. E. Capt. 10th Regt.
Bull, Fred. G. Lieut.-Col. h.p. 60th Royal Rifles
Buller, F. C. Capt. Colds. Gds.
Buller, Reginald J. Capt. Gr. Gds.
Buller, Wm. Gregory Lieut. 94th Reg.
Bullock, C. J. Comr. R.N. (1*l.*)
Bulwer, E. G. CB. Lt.-Col. 23rd Roy. Wel. Fus. (1*l.*)
Bunbury, Hen. W. CB. Col. (ret.) 24th Regt. (1*l.*)
Bunn, Rich. Capt. unatt. (1*l.*)
Bunyon, C. S. Lieut. unatt. (1*l.*)
Burden, Geo. Qr. Master 23rd R. W. Fus.
Burdett, Chas. Sedley Lieut.-Col. (ret.) Colds. Gds. (1*l.*)
Burgess, Ardwick Capt. Queen's Own L. I. Mil. (1*l.*)
Burgess, H. M. Lieut. R.A. Bengal (1*l.*)
Burgess, H. W. Capt. late Q. O. L. I. Mil. (1*l.*)
Burghley, Lord Lt.-Col. Northampton Mil. ADC. to *the Queen*, M.P.
Burgoyne, Hugh T. C. Capt. R.N. (1*l.*)

Burgoyne, *Sir* John Fox, *Bart.*, G.C.B. Gen. Col. Comt. R. E. Director of Works (1*l.*)
Burke, H. P. Capt. 91st Highldrs. (1*l.*)
Burlton, Wm. CB. Col. Bengal Army (1*l.*)
Burn, John M. Capt. Royal Art. (1*l.*)
Burn, Robert Major-Gen. R.A. (1*l.*)
Burn, R. D. M.D. Surg. R.A. (1*l.*)
Burnaby, E. S. Lieut.-Col. Gr. Gds.
Burnaby, F. G. Lieut. Roy. H. Gds. (1*l.*)
Burnaby, R. B. Major-Gen. late R.A. Col. Commt. Hants. Mil. Art. (1*l.*)
Burnand, N. Capt. Colds. Gds.
Burnell, E. S. P. Capt. Colds. Gds. (1*l.*)
*Burney, H. S. S. Maj. Paym. 6th Dep. Bn. (1*l.*)
Burrard, *Sir* Geo. *Bart.* Dep. Lieut. Hants. (1*l.*)
Burroughs, F. W. Maj. 93rd Highlanders (1*l.*)
Burroughs, L. Maj. (ret.) Bengal Army
Burton, H. A. Lieut. 14th Regt. (1*l.*)
Burton, J. E. Capt. 91st Highlrs.
Bury, W. C. Viscount Capt. late Edm. Rifle Mil.
Bussell, W. G. H. Capt. 23rd R. W. Fus. (1*l.*)
Butler, Henry, Esq. Admiralty (1*l.*)
Butler, Henry Thomas Lieut. 4th Huss. (1*l.*)
Butler, *Hon.* J. F. Clifford Major Mon. Rifle Vols. (1*l.*)
Butt, T. Bromhead Col. 86th Regt. (1*l.*)
Byham, W. R. Esq. late War Office (1*l.*)
Byng, A. M. Capt. Gr. Gds. (1*l.*)
Byng, *Hon.* H. W. J. Lieut.-Col. (ret.) Colds. Gds.
Byrne, Tyrrell M. Lieut.-Col. late 1st Royals
Byron, George Anson, Right Hon. Lord Adm.
Bythell, R. Lieut. and Adj. H.M. Bombay Sappers and Miners

CADELL, Thos. U.C. Lieut. H.M. Beng. Staff Corps
Cadogan, *Hon.* Geo. C.B. Maj.-Gen.
*Cafe, Haydon L. Maj. 94th Regt.
Caffin, James C. CB. Capt. R.N. Dir. of Stores and Clothing (1*l.*)
Caldbeck, William Lieut. late Limerick Mil. (1*l.*)
Calderon, C. M. Lieut. 60th Roy. Rifles (1*l.*)
Caldwell, W. B. Lieut.-Col. late 76th Regt. (1*l.*)
Calthorpe, *Hon.* Somerset J. G. Lt.-Col. 5th Drag. Gds.
Camden, Geo. Charles Marquis of Dep.-Lieut. Kent, KG. DCL. F.S.A. MA. (1*l.*)
Cameron, *Sir* D. A. KCB. Maj.-Gen. Col. 42nd Royal Highlanders (1*l.*)
Cameron, Jno. Lieut.-Col. R.E. (1*l.*)
Cameron, W. Gordon Lt.-Col. 4th Regt.
Campbell, Archibald Col. late Renfrew Mil.
Campbell, Arch. C. Lieut.-Col. Sco. Fus. Gds. (1*l.*)
Campbell, C. A. Capt. R.N. (1*l.*)
Campbell, Duncan Major h.p. unatt.
Campbell, F. A. Col. h.p. R. M. L. I. (1*l.*)
Campbell, George Capt. late 1st Drags.
Campbell, G. H. F. Col. Staff Officer of Pensioners, h.p. R. Staff Corps
Campbell, *Hon.* H. W. Capt. Colds. Gds.
Campbell, James Surg. h.p. 28th Regt. (1*l.*)
Campbell, James Major Roy. Art. Coast Brigade (1*l.*)
*Campbell, John R. Capt. Hants. Art. (1*l.*)
Campbell, Patk. John Capt. R. H. A.
Campbell, Walter Col. Staff Officer of Pensioners (1*l.*)
Campbell, W. M. T. Capt. R.E. (1*l.*)
Cannon, R. Lieut.-Gen. (1*l.*)
Cannon, Roquier J. Capt. (ret.) R.A. (1*l.*)
Capel, Sidney A. Major. Staff Officer of Pensioners, h.p. 51st Light Infantry
Carden, G. Major 5th Fus. (1*l.*)
Carew, Walter P. Capt. (ret.) R. H. Gds.
Carey, Constantine P. Capt. Roy. Eng. (1*l.*)
Carey, Geo. Jackson Col. 18th R. Irish (1*l.*)
Carey, T. A. Lt.-Col. H.M. Beng. Staff Corps (1*l.*)
Carey, W. N. Lieut. 21st R. N. B. Fus. (1*l.*)
Cargill, Sidney Lieut. 55th Regt. (1*l.*)
Carleton, Dudley W. Col. Colds. Gds.
Carleton, W. H. Capt. 21st R.N.B. Fus. (1*l.*)
Carnac, John Rivett Vice-Admiral (1*l.*)
Carpenter, F. S. Dep. Comr. General
Carpenter, G. W. W. Major (ret.) 32nd Lt. Inf. (1*l.*)
Carr, Ralph Capt. h.p. R.M.L.I. (1*l.*)
Carrick, S. A. Earl of Capt. (ret.) Gr. Gds.
Carter, T. Wren, CB. Vice-Adm. (1*l.*)
*Carter, Jno. M. Lieut.-Col. Adjt. Roy. Monmouthshire Militia
Cartwright, H. Col. late Gr. Gds. MP. (2*l.*)
Cartwright, R. Lieut. 15th Regt.
Case, John, Esq. Navy Agent
Cator, W. CB. Lt.-Gen. Col. Comm. R.A.
*Caulfield, J. A. Capt. late Colds. Gds. Major Royal Tyrone Fus.
Cavendish, H. G. Lieut. late 68th L. I.
Cavendish, Jas. Charles Capt. R.A. (1*l.*)
*Cavendish, W. H. F. Lieut.-Col. Commt. 2nd Derby Rifles, late 52nd L.I. (1*l.*)
Chads, *Sir* H. D. KCB. Admiral
Chads, Henry Capt. R.N. (1*l.*)
Chamberlain, *Sir* Henry O. R. Capt. late Hon. Corps Gent.-at-Arms (1*l.*)
Chamberlayne, D. T. Capt. late 13th Lt. Drags. (1*l.*)
Chamberlayne, J. Chamberlayne Lieut. h.p. R.A. (1*l.*)
Channer, A. W. Lieut. late 21st R.N.B. Fus. (1*l.*)
Chaplin, Edw. Lieut. Colds. Gds. (1*l.*)
*Chapman, A. T. L. Capt. 34th Regt. (1*l.*)
Chapman, F. E. CB. Col. Dep.-Adjt. Gen. R.E. (1*l.*)
Chapman, W. E. Ens. 18th Royal Irish (1*l.*)
Chapman, W. H. Capt. Leicester Mil. (1*l.*)
Chapple, Edward Lieut. 95th Regt. (1*l.*)
Charleton, T. H. Capt. 69th Regt.
Charlton, St. John W. C. Capt. h.p. 14th Huss.
*Charter, Ellis James Maj. (ret.) 11th Reg. (1*l.*)

Charteris, *Hon.* R. Lieut.-Col. (ret.) Sco. Fus. Gds.
Chase, C. R. Cornet 21st Huss.
Chase, Morgan C. Lt.-Col. (ret.) Madras Army
Chatterton, *Sir* James Charles, *Bart.* KCB. KH. Lieut.-Gen. Col. 5th Light Drags. (1*l.*)
Chatto, W. J. P. Ens. 23rd Middl. Rifle Vols. (1*l.*)
Chelmsford, LORD late Mid. R.N. (1*l.*)
Chermside, H. L. Lieut.-Col. R.A.
Chesney, Charles Cornwallis Capt. R.E. Prof. Mil. History Royal Mil. Col. Sandhurst
Chesney, F. R. DCL. FRS. Lieut.-Gen. Col. Commt. R.A. (1*l.*)
Chester, C. M. Maj. late R. Sussex Art.
Chetwynd, *Hon.* C. C. Capt. (ret.) 10th Reg. (1*l.*)
*Chichester, C. R. Major 19th Dep.-Batt. Fermoy (1*l.*)
Chichester, George Maj. late 88th Regt. (1*l.*)
Chichester, H. A. Capt. 81st Regt. (1*l.*)
Chichester, H. M. Lieut. (ret.) 85th Light Infantry (1*l.*)
Childers, J. W. Esq. Dep.-Lt. Yorkshire
Childs, James Capt. 4th Middl. Rifle Vols. (1*l.*)
Chin, Edw. Lieut. 4th K. O. Regt.
Chisholm, A. B. Lieut. 25th Regt. (1*l.*)
Cholmeley, H. H. Capt. late Gren. Gds.
Cholmondeley, LORD Hy. Dep.-Lt. Norfolk
Christie, Fred. Gordon Lieut.-Col. unatt. Staff Officer of Pensioners
Chrystie, T. Commr. R.N.
Churchill, C. H. S. Major 60th Royal Rifles
Chute, C. T. Lieut. R.N. (1*l.*)
Clark, A. Mj.-Gen. H.M. Madras Army (1*l.*)
Clark, John, KH. Major-General Col. 59th Regt.
*Clark, Thomas Major 24th Regt.
Clarke, Andrew Capt. R. E. (1*l.*)
Clarke, C. K. Lieut. 2nd West York Yeomanry Cavalry (1*l.*)
Clarke, C. M. Lieut. 57th Regt. (1*l.*)
Clarke, Edward Lieut. late 85th L.I.
Clarke, Guy Col. unatt. (1*l.*)
Clarke, H. S. Lieut. Royal Art. (1*l.*)
Clarke, Jno. Staff-Surg. (1*l.*)
Claxton, Christopher Capt. R.N. (1*l.*)
Clay, T. S. Capt. 103rd Roy. Bom. Fus. (1*l.*)
Clay, Wm. Lt.-Col. 8th Lan. Art. Vols. (1*l.*)
Clayton, Emilius Capt. late S. F. Gds. (1*l.*)
Clayton, F. A. T. Lt.-Col. Gr. Gds. (1*l.*)
Clayton, Fran. S. Lieut. Royal Navy (1*l.*)
Clayton, J. W. Capt. late 13th Lt. Drags. (1*l.*)
Clayton, V. C. Lieut. R.E. (1*l.*)
Cleather, E. J. Lt.-Col. h.p. R.S. Corps (1*l.*)
Cleeve, Steward A. Major 13th L. Inf. (1*l.*)
Clements, *Hon.* C. S. Capt. late 37th Regt. (1*l.*)
Clerk, H. Col. R.A. Supt. Royal Car. Depart. Woolwich (1*l.*)
Clerk, John Capt. 4th Dr. Gds. (1*l.*)
Clerke, St. J. A. KH. Lieut.-Gen. *Col. 75th Regt.* (1*l.*)
Clifford, *Sir* A. W. J. *Bart.* CB. Admiral (1*l.*)
Clifford, R. S. C. Col. late Gr. Gds. (1*l.*)
Clifton, *Sir* A. B. GCB. KCH. Gen. Col. 1st Royal Drags.
Clive, E. H. Lieut.-Col. Gr. Gds. (1*l.*)
Clode, C. M., Esq. Solicitor War Office
Cloete, *Sir* A. Josias, KCB. Lieut.-Gen., Col. 19th Regt. (1*l.*)
Close, F. A. Capt. R.N. (1*l.*)
Clowes, G. G. Major late 8th Hussars
Clutterbuck, G. W. Capt. 63rd Regt.
Coates, Chas. Capt. 99th Regt. (1*l.*)
Cobbe, C. P. Capt. (ret.) 13th Lt. Infantry
Cobbe, George Lieut.-Gen. Col. Commandant R.A.
Cochran, Thos. Capt. R.N. (1*l.*)
Cochrane, *Sir* Thomas J. GCB. Adm., Vice-Adm. of the United Kingdom (1*l.*)
Cockburn, A. Major 2nd N. Durham Mil.
Cockburn, C. V. Col. R.A.
Cockburn, *Sir* Francis Gen. Col. 95th Regt. (1*l.*)
Cockburn, J. E. Lieut. R.A. (1*l.*)
Cocks, Charles Lygon Lieut.-Col. late Colds. Gds. (1*l.*)
*Cocks, Oct. York. Major 4th K. O. Regt.
Codd, Edward Capt. R.N. (1*l.*)
Codrington, H. J. CB. Vice-Admiral (1*l.*)
Codrington, *Sir* W. J. KCB. Gen. Col. 23rd R. W. Fus. Gov. and Commander-in-Chief, Gibraltar (2*l.*)
Codrington, W. Wyndham Lieut. late 17th Lancers
Coe, E. O. Lieut. late Edmonton R. Rifle Regt. (1*l.*)
Coffey, J. A. Lieut. 1st Tower Hamlets Engr. Vols. (1*l.*)
Coke, *Hon.* E. K. W. Capt. late Colds. Gds.
Coke, *Hon.* W. C. W. Lieut.-Col. Sco. Fus. Gds. M.P.
Cole, J. A. Col. 15th Regt.
Cole, J. W. Lieut. h.p. 21st R.N.B. Fus. (1*l.*)
Cole, R. M. Com. R.N. (1*l.*)
Colebrooke, *Sir* W. M. G. CB.KH. Lieut.-Gen. Col. Comm. R.A. (1*l.*)
Coles, Cowper P. Capt. R.N. (1*l.*)
Coles, Josias R. J. Lt.-Col. late 9th Lancers
Coles, W. L. Esq. Pay.-Gen. Office (1*l.*)
Coles, W. C. Lieut.-Gen. (1*l.*)
Colley, G. P. Major 2nd Queen's (1*l.*)
Collier, C. MD. Dep. Ins. Gen. of Army Hosps. (1*l.*)
Collins, Caleb Ens. Cape M. Rifles (1*l.*)
Collin, Geo. Esq. late War Office
Collins, Wm. Louis Capt. Victoria Rifle Volunteers (1*l.*)
Collinson, Richard, CB. Rear-Adm. (1*l.*)
*Collinson, T. B. Lieut.-Col. R.E. Inst. Arch. Drawing R.E. Estab. Chatham (1*l.*)
Collis, W. Asst.-Surg. Roy. H. Art. (1*l.*)
Colman, J. B. T. Lt.-Col. late unatt.
Colomb, G. T. Maj.-Gen.
*Colomb, P. H. Comr. Royal Navy (1*l.*)
*Colthurst, D. L. Major 17th Regt. (1*l.*)
Colvill, Hugh Geo. Capt. late 29th Regt. (1*l.*)
Colvin, W. B. Capt. 7th Roy. Fus. (1*l.*)

Combermere, S. VISCOUNT, GCB. GCH. KSI. Field-Marshal, Col. 1st Life Guards
Coney, Bicknell Major late 17th Lancers
Congreve, Wm. Capt. 4th K.O. Regt. Brig. Maj. Chatham.
Conner, W. H. B. Capt. R. Lond. Mil.
Conolly, Jas. Col. Asst. Adj.-Gen. Montreal
Conolly, J. A. V.C. Lieut.-Col. Colds. Gds. (1*l.*)
Conran, Geo. A. Capt. Q.O.L.I. Mil. (1*l.*)
Conway, T. S. CB. Col. (ret.) Gr. Gds. (1*l.*)
Conway, W. S. Capt. late 2nd Life Gds.
Conyers, Charles E. Lieut.-Col. unatt. (1*l.*)
Conyngham, Francis N. MARQUIS of, KP. GCH. Maj. Gen. (1*l.*)
Coode, H. Comr. R.N.
Cook, Henry Major 100th Regt. (1*l.*)
Cooke, A. C. Major R. E. Executive Officer Topo. Dept. (1*l.*)
Cooke, W. B. Lieut. late 85th L.I.
Cooke, Wm. Capt. Hants Rifle Vols. (1*l.*)
Cooper, Edw. H. Lt.-Col. (ret.) Grn. Gds.
Cooper, Henry Major Q.O.L.I. Mil.
Cooper, *Rev.* Joseph, B.A. Chaplain R.N. (1*l.*)
Cooper, Richd. A. Capt. (ret.) Sco. Fus. Gds. (1*l.*)
Cooper, W. Cooper Maj. late Bedford Mil. (1*l.*)
Cooper, W. S. Com. R.N.
Coote, C. C. Capt. late 1st Royals (1*l.*)
Corballis, J. B. Capt. 10th Regt. (1*l.*)
Corbett, W. A. Lieut. 62nd Regt. (1*l.*)
Cormick, Jno. Col. 20th Regt. (1*l.*)
Cornes, J. E. Capt. R.E. Instr. in Fort. Roy. Mil. Acad. Woolwich (1*l.*)
Coryton, J. R. General R.M.L.I.
Cosby, T. P. Capt. 14th Regt.
Costin, C. Lieut. late 14th Regt. (1*l.*)
Cotton, Corbet Major-Gen. (unat.)
Cotton, *Hon.* Wellington H. S. Col. unatt. (1*l.*)
Cotton, Thos. F. Staff Surgeon h.p.
Costello, T. M. Surgeon R.N. (1*l.*)
Coulson, J. B. B. Capt. Rifle Brig.
Couper, H. E. Capt. 70th Regt. (1*l.*)
Court, H. M. Major (ret.) Madras Army (1*l.*)
Cousins, William Quar.-Mar. R.N. Asylum
Coventry, H. A. Capt. (ret.) Gren. Gds.
Cowburn, T. B. Lieut. 52nd Light Inf.
*Cowell, Henry Robert Capt. 3rd Buffs (1*l.*)
Cowell, J. C. Major R.E.
Cowen, Morrice Com. R.N.
Cowper, H. Paym. h.p. King's Germ. Leg.
Cox, A. C. W. Cornet 12th Roy. Lancers
Cox, C. H. Lieut. (ret.) 60th Royal Rifles (1*l.*)
Cox, Francis Edward Major R.E.
Cox, James Capt. late 92nd Highs.
Cox, R. Sneyd Capt. Hereford Mil.
Craigie, Peter E. CB. Lt. Gen. Col. 55th Regt. (1*l.*)
Cramer, J. H. Lt.-Col. (ret.) Madras Army
*Craufurd, F. A. B. Capt. R.N. (1*l.*)
Craufurd, J. R. Lieut.-Gen. Col. 27th Regt. (1*l.*)
*Craven, Chas. Dacre Capt. 5th W. York Mil. (1*l.*)
Craven, *Hon.* G. G. Lieut. Sc. Fus. Gds. (1*l.*)
Craven, J. A. Lieut. late Roy. H. Gds. (1*l.*)
Craven, Wm. George Lieut. late 1st Life Gds.
Crawford, Charles Lieut. R. E.
Crawford, Thos. MD. Staff Surg. (1*l.*)
Crawley, H. Owen Major-Gen. R.E. (1*l.*)
Crawley, Henry Lt.-Col. (ret.) h.p. 20th Regt.
Crawley, T. G. Lieut. 8th or King's
Crawley, T. R. Col. 6th Inniskilling Drags. (1*l.*)
Creagh, James Col. (ret.) h.p. 86th Regt. (1*l.*)
Creagh, John Capt. 5th Northum. Fus. (1*l.*)
Creagh, W. Capt. H.M. Bom. Staff Corps
Creed, Henry Capt. (ret.) Bombay Army Lt.-Col. 1st Middl. Art. Vols. (1*l.*)
Creser, Thomas Com. R.N. (1*l.*)
Creyke, A. S. Capt. R.E.
Crichton, *Hon.* C. F. Capt. Gren. Gds. (1*l.*)
Croft, C. P. Asst.-Surg. Victoria Rifle Vols.
Croft, W., Esq. late Assist.-Acct.-Gen.
*Crofton, Stephen S. L. Capt. R.N.
Crombie, Alexr. Major 72nd Highlanders
Crombie, T. Major Gen. (unatt.)
*Crosse, Joshua G. Major unatt. (1*l.*)
Crossman, William Capt. R.E. (1*l.*)
Crowe, Robert Lieut. h.p. unatt.
Crowe, S. M. Lieut. Kent. Art. Mil.
Crowther, R. W. B. Lieut. 63rd Regt.
Crozier, Rawson J. Col. (ret.) Bomb. Army (1*l.*)
Crozier, Rich. Rear-Adm. (1*l.*)
Cruikshank, A. R. Lieut. R.A.
Cuff, O. W. Lieut. Roy. Marine Art. (1*l.*)
Culpepper, J. R. Capt. late 14th Lt. Drags. (1*l.*)
Cumberland, C. E. Major R.E.
Cumberlege, N. Capt. late R. E. Mid. Mil.
Cumming, W. Gordon Major H.M. Bomb. Staff Corps
Cuningham, A. F. Lieut. 13th Light Inf. (1*l.*)
Cuninghame, W. J. M. V.C. Capt. Rifle Brig. (1*l.*)
Cunliff, *Sir* Rob. A. *Bart.* Capt. late Sco. Fus. Gds. (1*l.*)
Cunningham, Alex. Surg. h.p. 86th Regt.
Cunningham, A. W. Lieut. (ret.) R.A. (1*l.*)
Cunningham, H. D. Paymr. R.N. (1*l.*)
Cunningham, J. W. H. Capt. late 2nd Life Gds.
Cunninghame, J. Capt. 12th Lancers
Cuppage, Burke Major.-Gen. R.A. Lieut.-Gov. Jersey.
Cure, Alfred C. Col. Gr. Gds. (1*l.*)
Currie, A. D. Ens. 41st Regt. (1*l.*)
Currie, M. J. Rear-Adm. (1*l.*)
Currie, Raikes Dep.-Lt. Warwickshire
Curtis, Reginald Bt.-Major R.A. (1*l.*)
Curzon, *Hon.* E. G. Major 52nd L. I.
Curzon, *Hon.* R. W. P. CB. Col. (ret.) Gr. Gds.
Cust, *Hon.* C. R. late R.H. Gds.
Cust, Henry Francis Capt. North Salop. Yeo. Cav.
Cust, John Francis Lt.-Col. late Gr. Gds.

DACRES, *Sir* R. J. KCB. Maj.-Gen. Col. Comm. R.A. (1*l.*)
Dakyn, J. H. Surg. late St. Vincent Mil. (1*l.*)
Dalgety, J. W. Lt.-Col. late R.M. Coll.
Dalhousie, EARL, KT. GCB. Capt. late 79th Highlanders.
Dalrymple, *Sir* Adolphus J. *Bart.* Gen. (1*l.*)
Dalrymple, *Sir* H. *Bart.* Lt.-Col. late 71st L. I.
Dalrymple, J. VISCOUNT Capt. late Sco. Fus. Gds. Capt. Wigton Art. Vols. (1*l.*)
Dalrymple, J. H. E. Col. (ret.) Sco. Fus. Gds.
Dalton, Charles Maj.-Gen. R.A. (1*l.*)
Dalton, C. J. Col. R.A. (1*l.*)
Dalzell, *Hon.* A. A. Major-Gen., Col. 48th Regt., Comg. Forces, Dover (1*l.*)
Dalzell, R. A. Capt. Sco. Fus. Gds. (1*l.*)
Damer, S. L. Dawson Capt. late S. F. Gds. (1*l.*)
Dames, T. L. Capt. R.A. Inst. of Art. Roy. Mil. Academy, Woolwich (*l.*)
Dames, W. L. Major-Gen.
Dando, A. C. Lieut. Roy. Naval Reserve (1*l.*)
Dangan, LORD Lt.-Col. (ret.) Colds. Gds.
Daniel, R. H. Capt. 18th Royal Irish (1*l.*)
Daniell, C. F. T. Lt.-Col. unat. (1*l.*)
Daniell, Henry Col. late Colds. Gds. (1*l.*)
Daniell, John Major late 66th Regt.
*Darling, Sydney Major 9th Foot (1*l.*)
*Dartmouth, EARL of Capt. Staff. Rifle Volrs.
*Daubeny, A. G. Capt. 7th Fusiliers (1*l.*)
Daubeny, E. Capt. (ret.) 58th Regt. (1*l.*)
Daubeny, James CB. Col. 62nd Regt.
Daubeny, W. A. Capt. 3rd Buffs (1*l.*)
Daubuz, J. T. Capt. R.A. (1*l.*)
Davenport, W. B. Capt. 62nd Regt. (1*l.*)
Davidson, C. R. T. Lieut. R.E. (1*l.*)
*Davidson, D. Major (ret.) Bom. Army, Lt.-Col. City of Edin. Volrs. (1*l.*)
Davidson, Jno. Surg. (ret.) Beng. Army (1*l.*)
Davie, *Sir* H. R. Ferguson, *Bart.* Lt.-Gen.
Davies, Francis John Lt.-Gen. Col. 67th Regt.
Davies, Geo. S. Capt. h.p. 6th Drag. Gds. (1*l.*)
Davies, Henry F. Lt.-Col. Gren. Gds. (1*l.*)
Davies, John Capt. h.p. R.A. (1*l.*)
Davison, *Sir* W. KH. Lt.-Col. h.p. 2nd Queen's (1*l.*)
*Dawes, E. A. Capt. and Adjt. 2nd Royal Surrey Mil. (1*l.*)
Dawkins, W. G. Lt.-Col. Colds. Gds.
Dawson, *Hon.* E. S. Lieut. R.N. (1*l.*)
Dawson, Rob. N. Capt. R.E. (1*l.*)
Dawson, *Hon.* Vesey Lieut. Colds. Gds. (1*l.*)
Dawson, Wm. Commr. R.N. (1*l.*)
*Day, H. Capt. H.M. 19th Bombay N.I.
Deane, B. M. Major 18th Roy. Irish (1*l.*)
De Bathe, H. Perceval Col. Sc. Fus. Gds. (1*l.*)
De Bathe, *Sir* Will. P. *Bt.* Lt.-Col. late 53rd Regt.
De Blaquieu, LORD late 41st Regt. (1*l.*)
De Butts, J. C. B. Capt. R.E. (1*l.*)
De Cetto, M. H. E. Ens. 72nd Highlanders
Decie, Richard Capt. R.E. (1*l.*)
Deedes, W. Capt. late 30th Regt. (1*l.*)
De Grey and Ripon, EARL Sec. of State for War (2*l.*)
De Gruchy, W. L. Lieut. 4th Royal Jersey Mil.
*De Horsey, A. F. R. Capt. R.N. (1*l.*)
De Horsey, W. H. Beaumont Lieut.-Col. Gr. Gds. (1*l.*)
De la Condamine, T. Capt. h.p. unatt.
De Lacy, John Col. (ret.) 39th Regt.
Denison, S. C. Dep. Judge Adv. General
Denman, *Hon.* Joseph Rear-Admiral
Dennis, James B. Colonel R.A.
Dent, Edward Com. R.N. (1*l.*)
*De Robeck, Hastings St. J. Lieut. R.N. (1*l.*)
De Ros, *Hon.* D. C. F. Col. 1st Life Gds. (1*l.*)
De Ros, Wm. L. L. F. LORD Lt.-Gen. (1*l.*)
De Salis, Rodolph, CB. Col. 8th Huss. (1*l.*)
Desborough, John Lieut.-Col. R.A.
De Tessier, J. F. H. Lieut.-Colonel Invalid Depôt, Chatham (1*l.*)
De Thoren, O. W. Ens. 45th Regt. (1*l.*)
De Vere, H. F. Major R.E.
*Deverell, T. Josephus Col. 77th Regt.
Devereux, *Hon.* W. B. Rear-Admiral (1*l.*)
De Wahl, Thos. A. Com. R.N. (1*l.*)
Dewar, J. R. J. Lieut. R.A.
De Winton, F. W. Capt. R.A. (1*l.*)
De Winton, Walter Capt. late 1st Life Gds. (1*l.*)
De Winton, Wm. Lt.-Col. (ret.) Bomb. Army (1*l.*)
D'Eye, W. R. Capt. 91st Regt. (1*l.*)
Dickens, C. H. Lt.-Col. R.A. Bengal (1*l.*)
Dickenson, D. J. Lt.-Col. Brecon Mil. (1*l.*)
Dickenson, P. de M. Lieut. Roy. Sussex L.I. Mil. (1*l.*)
Dickenson, W. Lieut. late R.E.I. Vols. (1*l.*)
Dickins, C. S. S. Capt. late R. Sussex L. I. Mil.
Dickson, Chas. Sheffield Col. late British Swiss Legion
*Dickson, J. B. Capt. R.N. (1*l.*)
*Dighton, T. D. Capt. Lond. Rifle Brigade Vols. (1*l.*)
*Digweed, W. H. Major Hants Mil. (1*l.*)
Dillon, *Hon.* Arthur Dep.-Lieut., co. Mayo
*Dillon, Conrad A. Lieut. Oxford Mil. (1*l.*)
Dillon, H. A. Ens. Rifle Brig. (1*l.*)
Dinnen, J. Insp. of Machinery R.N. (1*l.*)
Disney, E. J. Capt. Essex Rifles late 7th Fus. (1*l.*)
Dixon, George Lieut.-Gen.
Dixon, John Lt.-Col. late Gren. Gds. (1*l.*)
Dixon, John Capt. h.p. unatt.
Dixon, W. Capt. Q. O. Lt. Inf. Mil. (1*l.*)
Dixon, Wm. Manly Hall Col. R.A. Supt. Roy. Small Arms Factory, Enfield (1*l.*)
Dobie, John Surg. R.N. (1*l.*)
Dobson, G. Rear-Admiral
Docker, E. S. Staff Surgeon
Doherty, D. H. Lieut. 3rd Huss. (1*l.*)
Dolby, J. E. A. Capt. late N. York. Rif. (1*l.*)
Domvile, *Sir* Charles C. W. Major late Dublin Co. L. I. Militia

Domvile, W. Capt. Worcester Militia
Domville, J. W. Col. R.A. (1*l.*)
Donaldson, Thos. Lieut. 3rd Huss. (1*l.*)
Donnelly, Thos. Lt.-Col. (ret.) Bombay Army (1*l.*)
*Doorly, M. Pay Mas. 4th W. I. Regt.
Dormer, *Hon.* J. B. J. Capt. (ret.) 74th Highlrs. (1*l.*)
Dorville, John W. Capt. R.N.
Douglas, A. K. Ens. 57th Regt. (1*l.*)
Douglas, Henry J. Capt. R.N.
Douglas, Jas. Stoddart Lieut. R.N. (1*l.*)
Douglas, *Sir* John, KCB. Col. late 79th Highlanders, Asst. Adj.-Gen. Edinburgh
Douglas, John, CB. Col. h.p. 11th Huss.
Douglas, Robert, CB. Gen. R.A.
Douglas, *Sir* Robert Percy, *Bart.* Major-Gen. Col. 98th Regt. (1*l.*)
Douglas, R. S. S. Lieut. Gr. Gds. (1*l.*)
Douglas, *Sir* Robert, *Bart.* Capt. 57th Regt. (1*l.*)
Douglas, Sholto Comr. R.N. (1*l.*)
Douglas, T. Monteath, CB. Lt.-Gen. H.M. Bengal Army (1*l.*)
Dowbiggin, M. H. Lt.-Col. 99th Regt.
Dowdeswell, J. M. Cornet 12th Lancers
Downes, H. F. Esq. Army Agent
Downes, M. F. Capt. R.A. (1*l.*)
Doyle, C. Hastings Major-Gen.
*Drake, J. Mervin C. Capt. R.E. (1*l.*)
Drake, Thomas George Com. R.N.
Drayson, Alfred Wilkes Capt. R.A. Asst. Instr. of Surveying Roy. Mil. Acad. Woolwich
Drew, Andrew Rear-Adm. (1*l.*)
Drummond, Alfr. M. Capt. late Rifle Brig. (1*l.*)
Drummond, Edgar A. Lieut. late R.N. (1*l.*)
Drummond, Hay, H. M. Lt.-Col. Commt. R. Perth Rifles
Drummond, Jas. Lieut. late 10th Huss. (1*l.*)
Drummond, John Lieut.-Gen. (1*l.*)
Drury, Byron, Capt. R.N.
Duberly, Wm. Capt. Gren. Gds. (1*l.*)
Ducane, E. F. Capt. R.E. (1*l.*)
Ducane, F. Major (ret.) R.E. (1*l.*)
Ducie, EARL of Lord Lieut. Gloucestershire Capt. H.M. Roy. Body Guard (1*l.*)
Dudgeon, R. C. Major 61st Regt. (1*l.*)
Duff, A. M. Lieut. 74th Highlanders (1*l.*)
Duff, James Maj. late 23rd R. W. Fus. (1*l.*)
Duff, R. W. Capt. R.E. (1*l.*)
Dumaresque, Henry Capt. R.N.
Dumbreck, David, C.B. Inspector-General of Army Hospitals
Dunbar, W. M. Capt. 24th Regt.
Duncan, Fras. Lieut. R.A. (1*l.*)
Duncombe, *Hon.* A. Vice-Adm. M.P.
Duncombe, *Hon.* Cecil Capt. 1st Life Gds.
Duncombe, C. W. Lieut. 1st Life Gds.
Duncombe, George T. Capt. late 16th Regt.
Dundas, P. Colonel (ret. f. p.) 47th Regt. (1*l.*)
Dundas, Thomas Major 12th Regt. (1*l.*)
Dunkellin, U. C. LORD Lt.-Col. (ret.) Coldm. Gds.
Dunlevie, W. S. H. Lieut. 12th Regt. (1*l.*)
Dunlop, Franklin, C.B. Col. R.A.
Dunmore, EARL of Lt. (ret.) S. Fus. Gds. (1*l.*)
Dunn, James, Esq. Ens. (ret.) 41st Regt. (1*l.*)
Dunne, F. Plunkett Colonel Queen's County Mil. M.P. (1*l.*)
*Dunne, J. H. Major 99th Regt.
Dunsany, Edw. *Rt. Hon.* LORD Capt. R.N.
Dunscombe, N. Capt. 2nd Queen's
Dupuis, J. E. CB. Major-General R.A. (1*l.*)
D'Urban, Wm. J. Major-Gen.
Durham, P. F. Capt. late 37th Regt. Adj. Royal Cardigan Rifles
Durie, Charles Major unatt.
Durnford, F. A. Capt. 2nd Surr. Artil. Vols. (1*l.*)
Dyke, Charles Lieut. R.N.
Dynevor, G. R. LORD Col. R. Carmar Mil. *ADC. to the Queen* (1*l.*)
Dyson, Edward Major late 3rd Dr. Gds. (1*l.*)
Dyson, J. D. Col. late 3rd Dr. Gds.

EARLSFORT, J. H. R. LORD Lt. 1st Life Gds.
*East, Cecil J. Capt. 82nd Regt. (1*l.*)
Eastwick, W. J. Capt. (ret.) Bomb. Army (1*l.*)
Eckford, Rob. Capt. 23rd R. W. Fus. (1*l.*)
Eden, Charles, CB. Rear-Admiral, Lord of the Admiralty
Eden, John, C.B. Lt.-Gen. Col. 34th Regt.
Eden, J. Capt. late 14th Lt. Dr.
Eden, T. M. B. Lieut. 50th Regt.
Eden, Walter, D. Esq. Admiralty
Eden, Wm. Hassall Lieut.-Gen. Col. 90th Light Inf. (1*l.*)
Edenborough, Horatio Capt. W. Essex Mil.
Edgar, Joseph Haythorne Lieut. late R.A. (1*l.*)
Edgcumbe, *Hon.* C. E. Capt. Gr. Gds. (1*l.*)
Edgell, Harry E. CB. Capt. R.N. *ADC. to the Queen.*
Edgell, A. Wyatt Lt. (ret.) 10th Huss. (1*l.*)
Edmeades, H. Capt. R.A. (1*l.*)
Edwards, C.A. CB. Col. (ret.) 49th Regt.
Edwards, C. Capt. Invalids R. H. Chelsea
Edwards, J. B. Major R.E.
Edwards, Nathaniel E. Capt. R.N.
Edwards, Peter Lieut.-Gen. (1*l.*)
Edwards, *Hon.* W. Capt. Colds. Gds.
*Egerton, Caledon. Rich. Col. Com. 8th Dep. Batt. Pembroke (1*l.*)
Egerton, C. R. Commr. R.N. (1*l.*)
*Egerton, *Hon.* Francis Capt. R.N. (1*l.*)
Egerton, F. P. Com. R.N.
*Egerton, F. W. Lieut. R.N. (1*l.*)
Egerton, *Sir* P. de Malpas Grey, *Bart.* F.R.S. Lt.-Col. Cheshire Yeomanry (1*l.*)
Egerton, P. de R. Capt. late Coldstrm. Gds. (1*l.*)
Egerton, *Hon.* S. J. G. Lieut. 1st Lf. Gds.
Egerton, W. W. Ens. 8th or King's
Eglese, Joseph Capt. Hon. Art. Co. (1*l.*)
Elcho, LORD Col. Lond. Sco. R. Vols. (1*l.*)
Elderton, E. H. P. Capt. (ret.) 26th Regt.
Elderton, Edw. M. Esq. late H. A. Co. (1*l.* 1*s.*)

Elgee, C. W. Capt. R. A. (1*l.*)
Eliot, *Hon.* C. G. C. Capt. Gr. Gds.
Elkington, A. G. Asst. Surg. S. F. Gds.
*Elles, W. K. Capt. 38th Regt. (1*l.*)
Ellicombe, *Sir* Chas. Greene, KCB. Gen. Col. Commt. R.E.
Elliot, Geo. Rear-Adm. (1*l.*)
Elliot, *Hon.* Gilbert Lt.-Col. late R. Brig. 15th Depôt Batt. (1*l.*)
Elliot, *Sir* W. H. KCB. KH. Lieut.-Gen. Col. 51st K.O.L.I.
Elliott, *Hon.* Charles G. J. B. CB. Rear-Admiral
Ellis, C. H. Fairfax Lieut. R.A. (1*l.*)
Ellis, Fred. Capt. late 9th Lancers (1*l.*)
*Ellis, J. H. Chief Engr. R.N. (1*l.*)
Ellis, Nelson Lt. 101st Roy. Ben. Fus. (1*l.*)
Ellis, William Captain R.N. (1*l.*)
Ellis, W. B. E. Capt. R.A.
Ellison, C. G. Lieut.-Col. (ret.) Gr. Gds.
Ellison, R. G. Major h.p. 47th Regt. (1*l.*)
Elphinstone, *Hon.* J. F. B. Capt. S. F. Gds.
Elrington, F. R. Col. Rifle Brig.
Elrington, W. F. Lt.-Col. late Sco. Fus. Gds.
Elwes, W. C. C. Capt. 71st High. L. Inf.
Elwyn, Thomas Col. R.A. Mem. of Coun. of Education (1*l.*)
Emmett, Anthony Major-Gen. R.E.
Enfield, VISCOUNT Col. Edmonton R. Rifles
England, *Sir* Rich. GCB. KH. Gen. Col. 41st Regiment
England, Richd. Major 55th Regt. (1*l.*)
Enniskillen, W. W. EARL of, FRS. Col. Fermanagh Militia (1*l.*)
Errington, A. C. Col. 51st K.O.Lt. Inf. (1*l.*)
Errington, A. J. Lieut. R.N. (1*l.*)
Erskine, J. Elphinstone Rear-Adm. (1*l.*)
Erskine, W. H. K. Capt. late 17th Lancers
Espie, Robert, Esq. Surgeon R.N.
*Espinasse, James W. Major 12th Regt. (1*l.*)
Estridge, Geo. Lt.-Col. St. Kits Mil. (1*l.*)
Eustace, T. F. Lieut. late 49th Regt. (1*l.*)
Evans, *Sir* De Lacy, GCB. Gen. Col. 21st R.N.B. Fus.
Evans, George Rear-Adm. (1*l.*)
Evans, H. D. Lieut. 10th Huss. (1*l.*)
Evans, John Capt. 6th Inniskilling Drags. (1*l.*)
Evans, Jno. T. Lieut. (ret.) 74th Highs. (1*l.*)
Evelegh, G. C. Capt. h.p. R.A.
Evelyn, C. F. Capt. 3rd Roy. Surrey Mil. (1*l.*)
Everard, Walling Capt. late 60th Roy. Rifles
Ewart, Henry P. Capt. 2nd Life Gds.
Ewart, W. S. Lt.-Col. Gren. Gds. (1*l.*)
Eyre, Vincent, CB. Major Gen. R.A. Bengal (1*l.*)

FABER, W. Raikes Major-General
Faddy, Peter Major-General R.A.
Fairfax, T. E. Capt. Gr. Gds.
Fairfield, Charles Ens. Rifle Brig. (1*l.*)
Fairtlough, J. W. Col. (ret.) 63rd Regt.
Falconar, Hugh, MD. Surg. (ret.) Ben. Army
Falls, John Paym. 8th or King's
Fane, Mildmay Gen. Col. 54th Regt. (1*l.*)
Fanning, John Major (ret.) f.p. 1st W. I. Regt. (1*l.*)
Fanshawe, Charles Col. R.E.
Fanshawe, Hew D. Lt.-Col. unatt.
*Farquhar, Arthur Capt. RN. (1*l.*)
Farquharson, G. Mc. Capt. 21st Bomb. N.I. (1*l.*)
Farquharson, Henry Capt. 8th or King's (1*l.*)
Farquharson, J. R. Lt.-Col. S.F. Gds.
Farrell, J. Sidney Major (ret.) R.A.
Farrell, Sydney B. R.E. Capt. Prof. of Mil. Topogy. Staff Coll. Sandhurst (1*l.*)
Farrier, Jas. Qua.-Masr. R. Hosp. Chelsea
Farrington, M. C. Capt. 51st K.O.L. Inf. (1*l.*)
Fawkener, Lyon, Esq. late Ordn. Dep.
Fearnly, Fairfax Capt. 18th Roy. Irish (1*l.*)
Feilden, Henry Lieut. 21st R.N.B. Fus. (1*l.*)
Feilden, H. M. Capt. 1st Roy. Lanc. Mil.
Feilden, Randle J. Lieut.-Col. 60th Royal Rifles (1*l.*)
Feilding, Geo. Col. (ret.) Beng. Army
Fellowes, Edward Lt.-Col. late 11th Hus. Assist. Adj.-Gen. Cape of Good Hope.
Fellowes, P. H. Lt.-Col. R. Marine L.I.
Fenning, S. W. Lieut.-Col. unatt. (1*l.*)
Ferguson, G. A. Lt.-Col. Gren. Gds.
Fergusson, *Sir* Jas. GCB. Gen. Col. 42nd L. I. (1*l.*)
Fergusson, *Sir* Jas. *Bart.* Capt. late G. Gds. Col. Ayrshire Rifles, M.P.
Field, Æsculapius, Esq. late Hon. Corps Gent.-at-Arms
Field, C. F., Esq. late Admiralty (*l.*)
Field, *Rev.* E. B. BCL. late Act. Chaplain to the Forces
Field, G. T. Lt.-Col. R.A. (1*l.*)
Field, J. W. P. Capt. Hon. Art. Coy. (1*l.*)
Filgate, T. P. H. M. Capt. 2nd R. N. B. Dragoons
Filkin, R. MD. Surgeon late N. Glouc. Mil.
Filmer, *Sir* Edm. *Bart.* Cornet Roy. East Kent Yeo. Cav.
Finch, J. W. Capt. R.N. (1*l.*)
Finucane, George Col. (ret. f.p.)
Fischer, John F. Capt. R.E. (1*l.*)
Fisher, A. A'Court, CB. Lt.-Col. R.E. (1*l.*)
Fisher, H. C. Capt. West Essex Mil.
Fitzgerald, E. Lt.-Col. late 98th Regt.
Fitzgerald, M. G. B. Capt. unatt. (1*l.*)
Fitzgerald, P. S. Capt. 2nd Roy. Lanc. Rifles
Fitzgerald, R. P. Lieut. R.N. (1*l.*)
Fitzhugh, H. T. Major R.A. Capt. of Company Roy. Mil. Academy, Woolwich (1*l.*)
Fitzjames, Arthur Chas. Major late 23rd Highs.
Fitzroy, LORD A. C. Lennox Col. unatt. (1*l.*)
Fitzroy, C. C. Capt. 68th Light Inf. (1*l.*)
Fitzroy, LORD F. J. Lt.-Col. late Gr. Gds. (1*l.*)
Fitzroy, Philip Capt. 5th Fus. (1*l.*)
Fitzroy, Robert, FRS. Vice-Adm.
Fleming, James Col. late of 55th Regt.
Fletcher, *Sir* Henry *Bart.* Lieut. late Gr. Gds. Major Surrey Rifle Vols.
Fletcher, Henry C. Lieut.-Col. Sco. Fus. Gds. (1*l.*)

Fletcher, T. H. Captain Military Train (1*l.*)
*Flower, Lamorock Capt. 3rd Roy. Sur. Mil. (1*l.*)
Fludyer, C. Capt. Gren. Gds.
Fogo, James Maj.-Gen. (ret.) R.A.
Foley, *Hon.* A. F. Col. late Gr. Gds.
Foley, *Hon.* St. Geo. Gerald CB. h.p. 44th Regt. (1*l.*)
Fonblanque, B. A. Ens. 8th or King's
Fonblanque, E. B. de Asst. Com.-Gen. (1*l.*)
Fonblanque, J. S. M. de Grenier, Lt. h.p. 21st R.N.B. Fus. (1*l.* 1*s.*)
Foot, Alfred G. Lieut. Roy. Eng. (1*l.*)
Forbes, G. H. A. Capt. R.A.
Forbes, J. Lieut.-Col. late Colds. Gds.
Forbes, Leslie Jonathan Lieut.-Col. late 78th Highlanders
Forbes, Stewart Capt. 1st Roy. Surrey Mil.
Forbes, Thos. Jn. Gen. Col.-Com. R.A. (1*l.*)
Forbes, *Sir* William, *Bt.* Lieut. late Colds. Gds. Capt. Aberdeen Rifle Vols.
*Forbes, *Hon.* W. F. Maj. Leitrim Rifles (1*l.*)
Ford, Chas. Erskine Col. R.E.
Ford, Edmund Twiss Col. R.E.
Ford, James E. Capt. Sco. Fus. Gds.
Forester, *Hon.* H. T. Lt.-Col. late Gr. Gds.
Forster, B. L. Lieut. Roy. Art.
Forster, F. R. Lt.-Col. 4th R. I. Dr. Gds.
Forster, J. F. Ens. Ceylon Rifles
Forsyth, J. Lieut. Beng. Staff Corps.
Fortescue, Francis Capt. late Sco. Fus. Gds.
Fortescue, H. G. Capt. Colds. Gds.
Fothergill, T. Lt.-Col. late 10th Regt. (1*l.*)
Fowler, A. R. Capt. 41st Regt. (1*l.*)
Fowler, G. C. Com. R.N.
Fowler, Robert Dashwood Commr. R.N.
Fox, Augustus H. Lane Lieut.-Col. Gren. Gds. Assist.-Qr.-Mr.-Gen. Cork (1*l.*)
Fox, Edwin Lieut. H. A. Comp.
Fox, J. T. R. Lane Capt. Gren. Gds. (1*l.*)
Fox, Maxwell Commr. R.N. (1*l.*)
Frampton, W. J. Lieut. 59th Regt. (1*l.*)
Frank, P. late Assist. Staff Surg.
Franklen, C. R. Capt. Roy. Art.
Fraser, *Hon.* Alex. E. Lt.-Col. late S.F. Gds. (1*l.*)
Fraser, Daniel Col. (ret. f.p.) 42nd Royal Highlanders (1*l.*)
Fraser, J. Keith Capt. 1st Life Gds. (1*l.*)
Fraser, Thomas Rear-Adm. (1*l.*)
Fraser, W. Col. unatt. (1*l.*)
Fraser, W. J. Lieut. 1st Tower Hamlets Eng. Vol. (1*l.*)
Frederick, Charles Rear-Adm. Lord of the Admiralty.
Frederick, *Sir* R. *Bt.* Lt.-Col. late 2nd Sur. Mil. (1*l.*)
Freeland, Russell G. Ens. 4th K. O. (1*l.*)
Freer, C. T. Lieut. late 7th Fus.
Freese, J. N. A. CB. Major-Gen. (ret.) f.p. R.A.
Freeth, *Sir* James, KCB. KH. Lieut.-Gen. Col. 64th Regt. (1*l.*)
Fremantle, A. J. Lieut.-Col. Colds. Gds.
Fremantle, *Sir* Charles Howe, KCB. Vice-Adm.
Fremantle, E. R. Commr. R.N. (1*l.*)
Fremantle, Fitzroy W. Capt. Colds. Gds. (1*l.*)
Fremantle, J. C. S. Lieut. 10th Hussars (1*l.*)
French, H. J. Maj.-Gen.
French, Jas. M.D. late Ins.-Gen. of Army Hos.
French, P. T. Lt.-Col. (ret.) Bomb. Army
Frobisher, W. M. Lieut. 55th Regt. (1*l.*)
Frome, Edw. Major-Gen. R.E. (1*l.*)
Fugion, Edw. Major unatt. (1*l.*)
Fulford, Wm. Major (ret.) R.A.
Fuller, F. G. A. Capt. R. H. Gds.
Fuller, T. Capt. 18th Huss. (1*l.*)
Fullerton, A. G. Major late 2nd Life Gds.
Fulton, J. J. Capt. Mad. Staff Corps
Furlong, Geo. W. Capt. 21st R. N. B. Fus. (1*l.*)
Furlong, J. S. M.D. Surg. 6th Inns. Drs. (1*l.*)
*Fyers, Henry Thomas Major h.p. R.A. Col. E. and N. York Art. Mil. (1*l.*)

GAGE, E. Major late Sco. Fus. Gds.
Gage, *Hon.* E. T. Col. Roy. Art. (1*l.*)
Gage, *Hon.* H. E. Hall Lt.-Col. R. Sussex L. I. Mil. (1*l.*)
Gage, VISCOUNT Major late Sus. Mil. (1*l.*)
Galbraith, W. Lieut. 85th K. L. I. (1*l.*)
Galloway, T. J. Maj.-Gen.
Galton, Douglas Capt. (ret.) R.E. Asst. Under Secretary of State for War, F.R.S.
Gambier, Gloucester, CB. Col. R.H.A.
Gammell, A. Major late 43rd Regt.
Gammell, J. H. H. Capt. 9th Regt. (1*l.*)
Gardiner, R. Col. I. F. O. Glasgow (1*l.*)
Gardiner, T. Esq. late Purser H. E. I. C. S. (1*l.*)
Gardiner, W. Commr. R.N
Gardner, G. H. Capt. R.N. (1*l.*)
Gardner, W. B. Col. Roy. Art. (1*l.*)
Gardyne, C. Greenhill Capt. Coldm. Gds.
Garforth, Wm. Commr. R.N. (1*l.*)
Garlies, Adam P. LORD Capt. R. H. Gds.
Garnett, A. P. Capt. 11th Hussars
Garratt, J. A. T. Lieut. Gr. Gds. (1*l.*)
Garrett, Francis Capt. late 3rd Drag. Gds. Lieut. Royal 1st Devon Yeom. Cav. (1*l.*)
*Garsia, M. C. Lieut. 56th Regt. (1*l.*)
Garstin, R. L. Col. (ret.) R.A.
Garvock, John Col. h.p. 31st Regt. Brig. Gen. Shorncliffe
Gascoigne, Chas. Lieut.-Gen. Col. 89th Regt. (1*l.*)
Gascoigne, Clifton Capt. Gr. Gds. (1*l.*)
Gascoigne, Ernest F. Lieut.-Gen. Col. 69th Regt. (1*l.* 1*s.*)
Gascoigne, W. Lieut. Sco. Fus. Gds. (1*l.*)
Gawler, Geo. KH. Col. late of 52nd L. I. (1*l.*)
Gearey, H. L. Capt. R.A. (1*l.*)
George, Christopher Commr. R.N. (1*l.*)
George, F. D. CB. Col. unatt. (1*l.*)
George, G. T. Lieut.-Col. late Paym. 4th Huss.
German, James Capt. 3rd Roy. Lan. Mil. (1*l.*)
Gibb, Charles John Lieut.-Col. R.E.

Gibbings, Thos. Lt.-Col. (ret.) 2nd W. I. Regt. (1*l.*)
Gibbon, Arthur, Esq. Acct.-Gens. Branch, War Office (1*l.*)
*Gibbons, Charles Commr. R.N. (1*l.*)
Gibbons, John Surgeon 95th Regt.
Gibbs, Charles Capt. 2nd Queen's (1*l.*)
Gibson, Charles E. Capt. 3rd Regt. or Buffs
Gibson, Edgar Lieut.-Col. unatt.
Giffard, Edw. Esq. Admiralty
Gilbard, Geo. J. Capt. 13th Huss. (1*l.*)
Giles, John C. Captain R.N.
Gilford, Viscount Capt. R.N. (1*l.*)
Gill, T. Mc N. Lieut. 13th Lt. Inf. (1*l.*)
Gilmore, A. H. Lieut. R.N. (1*l.*)
Gilmour, C. D. Capt. R.A.
Gilpin, Rich. T. Col. Bedford. Mil. MP.
Gipps, F. B. Lieut. 35th Roy. Sussex Regt. (1*l.*)
Gipps, H. Capt. 9th Regt.
Gipps, Reginald Lt.-Col. Sco. Fus. Gds.
Gledstanes, H. B. Lieut. 75th Regt. (1*l.*)
Gleig, A. C. Lieut.-Col. R.A. Asst. Insp. of Schools
Gleig, C. E. S. Bt.-Major h.p. 14th Regt.
Gleig, *Rev.* G. R. M.A. Chaplain-General to the Forces (1*l.*)
Glover, Stirling F. Lt.-Col. late 12th Regt.
Glyn, Rich. G. Capt. late 1st R. Drags.
Godbold, G. B. Capt. Adj. 1st Batt. Renfrewshire Rifle Vols.
Godley, W. A. Capt. 56th Regt. (1*l.*)
Godson, Chas. Asst.-Surg. Edmonton R. Rifles
Godwin, A. A. Lieut. 103rd Roy. Bomb. Fus.
Godwin—Austen H. H. Capt. Beng. Staff Corps (1*l.*)
Goff, Robert Charles Capt. 15th Regt. (1*l.*)
Goff, Thos. Wm. Capt. late 7th Drag. Gds. M.P. (1*l.*)
Gold, W. Geo. Major-Gen. (1*l.*)
Goldney, *Rev.* J. K. MA. Chaplain R.N. (1*l.*)
Goldsmith, George, CB. Rear-Adm. (1*l.*)
Goldsworthy, W. T. Capt. 91st Highlrs. (1*l.*)
Gomm, *Sir* Wm. M. GCB. Gen. Col. Colds. Gds. (1*l.*)
Gooch, H. Lieut.-Col. late Colds. Gds. (1*l.*)
Good, James Staff Asst. Surg.
Goode, W. H. Major late 62nd Regt. (1*l.*)
Goodenough, W. H. Major R.A. (1*l.*)
Goodfellow, W. B. Major-Gen. R.E.
Goodlake, G. L. V.C. Lt.-Col. Coldm. Gds.
Goodliffe, F. G. Lieut. Lond. Rifle Brigade Vols. (1*l.*)
Goodsman, David Lieut.-Gen. (2*l.*)
Goolden, G. B. Lieut. R.N.
Goose, William Capt. R.N. (1*l.*)
Gordon, *Sir* Jas. A. GCB. Admiral (1*l.*)
Gordon, *Hon.* Alex. CB. Major-Gen. (1*l.*)
Gordon, F. A. Ens. 60th Royal Rifles (1*l.*)
Gordon, G. Grant Lieut.-Col. Sco. Fus. Gds.
Gordon, George Hamilton Capt. R.E. (1*l.*)
Gordon, H. W. Col. Comm. Lieut.-Gen. R.A.
Gordon, Henry W. Esq. CB. Principal Superintendent of Stores, Woolwich
Gordon, *Hon.* John
Gordon, John Lieut.-Col. late 47 (1*l.*)
Gordon, J. S. Capt. 3rd B
Gordon, Robt. Rear-A
Gordon, William V
Gore, *Hon. Sir* Charles, KCB. KH. Col. 6th Regt.
Gore, W. R. O. Major late 13th Li
Gorges, A. H. Lieut. R. H. A
Gosling, Geo. Lieut. Sco. Fus. G
Gosselin, Nicholas Lieut. (ret.) 23rd Fus. (1*l.*)
Gosset, Charles Lieu
Gosset, H. Allen Lieut. Paym. 75th (1*l.*)
Gossett, W. D. Lieut.-Col. R
Gough, Hugh, Viscount, KP. GCB Field-Marshal, Col. Royal Horse Gu
Gough, Hugh Capt. late 1st Drags.
Goulburn, Edward Col. late Gra
Gould, F. A. Lt.-Col. late 2nd (1*l.*)
Gould, Henry O. Capt. Gren. Gd
Gould, T. T. Lieut. 13th Light In (1*l.*)
Gower, Erasmus Capt. 12th Royal
Graeme, C. H. Major-Gen. (ret.) Indian Army
Graeme, *Rev.* G. Mil. Chap. H.R.H. (1*l.*)
Graham, Allan Capt. Renfrewshi Vols. (1*l.*)
Graham, Allan Ham. Col
Graham, Gerald Lieut.-Col. Roy. En
Graham, H. A. Lieut. late 7th Fu
Graham, Jas. John Col. Staff Of Pensioners, Regent's Park Barrack
Graham, Lumly Lt.-Col. 19th Re
Graham, T. P. Lieut. Sco. Fus. Gd
Grahame, Francis Barclay Lt. late F and Kincardine Mil.
Grahame, Geo. Quar. Mastr. 21st R Fus.
*Grange, Chas. Walter Major R. Can
Grant, Edward Fitzherbert Col. (ret.)
Grant, Geo. Fox Lieut. 62nd Re
Grant, *Sir* James Hope Lieut-Ge Col. 4th L. Drag. (1*l.*)
Grant, John Capt. (ret.) R.A
Grant, John M. Capt. R
Grant, J. M. Lieut. 85th L
Grant, J. Thornton, CB. Col. 18th
Grant, J. W. Surg. (ret.) Bengal Arm
Grant, Wm. Lieut. 91st High
Grant, W. F. Col. (ret.) Bengal Arm
Grant, W. L. Lt.-Col. K. O. Lt. In
Granville, B. Maj. 2nd Warwick Mi
Gratton, A. O. D. Lieut.-Col. R
Gray, Basil Capt. unatt
Gray, W. J. Capt. R.A
Graydon, Geo. Col. Roy. Art
Greathed, E. H. CB. Col. unatt
Greathed, W. W. H. CB. Lt.-Col. R gal. Asst. Mil. Secretary (1*l.*).
Greaves, R. Lieut.-Gen. Col. 40th

Fletcher, T. H. Captain Military Train (1*l.*)
*Flower, Lamorock Capt. 3rd Roy. Sur. Mil. (1*l.*)
Fludyer, C. Capt Gren. Gds.
Fogo, James Maj.-Gen. (ret.) R.A.
Foley, *Hon* A. F. Col. late Gr. Gds.
Foley, *Hon.* St. Geo. Gerald CB. h.p. 44th Regt. (1*l.*)
Fonblanque, B. A. Ens. 8th or King's
Fonblanque, E. B. de Asst. Com.-Gen. (1*l.*)
Fonblanque, J S. M. de Gremer, Lt. h.p. 21st R.N B. Fus. (1*l.* 1*s.*)
Foot, Alfred G. Lieut. Roy. Eng. (1*l.*)
Forbes, G. H. A. Capt. R.A.
Forbes, J. Lieut.-Col. late Colds Gds.
Forbes, Leslie Jonathan Lieut.-Col. late 78th Highlanders
Forbes, Stewart Capt. 1st Roy. Surrey Mil.
Forbes, Thos. Jn. Gen. Col.-Com. R.A.(1*l.*)
Forbes, *Sir* William, *Bt* Lieut. late Colds. Gds. Capt. Aberdeen Rifle Vols.
*Forbes, *Hon.* W. F. Maj. Leitrim Rifles (1*l.*)
Ford, Chas. Erskine Col. R.E.
Ford, Edmund Twiss Col. R.E
Ford, James E Capt. Sco. Fus. Gds.
Forester, *Hon.* H. T. Lt.-Col. late Gr. Gds.
Forster, B. L. Lieut. Roy. Art.
Forster, F. R. Lt.-Col. 4th R I. Dr Gds.
Forster, J. F Ens. Ceylon Rifles
Forsyth, J. Lieut. Beng. Staff Corps.
Fortescue, Francis Capt. late Sco. Fus. Gds.
Fortescue, H. G. Capt. Colds Gds.
Fothergill, T. Lt.-Col. late 10th Regt (1*l.*)
Fowler, A. R. Capt. 41st Regt. (1*l.*)
Fowler, G. C. Com. R.N.
Fowler, Robert Dashwood Commr. R.N.
Fox, Augustus H. Lane Lieut.-Col. Gren. Gds Assist.-Qr.-Mr.-Gen. Cork (1*l.*)
Fox, Edwin Lieut. H. A Comp.
Fox, J. T R Lane Capt. Gren Gds. (1*l.*)
Fox, Maxwell Commr R.N. (1*l.*)
Frampton, W. J. Lieut. 59th Regt. (1*l.*)
Frank, P. late Assist. Staff Surg.
Franklen, C. R. Capt Roy. Art.
Fraser, *Hon.* Alex. E. Lt.-Col. late S.F. Gds (1*l.*)
Fraser, Daniel Col. (ret. f.p.) 42nd Royal Highlanders (1*l.*)
Fraser, J. Keith Capt. 1st Life Gds. (1*l.*)
Fraser, Thomas Rear-Adm. (1*l.*)
Fraser, W. Col. unatt. (1*l.*)
Fraser, W. J. Lieut. 1st Tower Hamlets Eng. Vol. (1*l.*)
Frederick, Charles Rear-Adm. Lord of the Admiralty.
Frederick, *Sir* R. *Bt.* Lt.-Col. late 2nd Sur. Mil. (1*l.*)
Freeland, Russell G. Ens. 4th K. O. (1*l.*)
Freer, C. T. Lieut. late 7th Fus.
Freese, J. N. A. CB. Major-Gen. (ret.) f.p. R.A.
Freeth, *Sir* James, KCB. KH. Lieut.-Gen Col. 64th Regt. (1*l.*)
Fremantle, A. J. Lieut.-Col. Colds. Gds.
Fremantle, *Sir* Charles Howe, KCB. Vice-Adm.
Fremantle, E. R. Commr. R.N. (1*l.*)
Fremantle, Fitzroy W. Capt. Colds. Gds. (1*l.*)
Fremantle, J. C. S. Lieut. 10th Hussars (1*l.*)
French, H. J. Maj.-Gen.
French, Jas. M.D. late Ins.-Gen. of Army Hos.
French, P. T. Lt.-Col. (ret.) Bomb. Army
Frobisher, W. M. Lieut 55th Regt. (1*l.*)
Frome, Edw. Major-Gen R.E (1*l.*)
Fugion, Edw. Major unatt. (1*l.*)
Fulford, Wm. Major (ret.) R.A.
Fuller, F. G. A. Capt. R H Gds.
Fuller, T. Capt. 18th Huss (1*l.*)
Fullerton, A. G. Major late 2nd Life Gds.
Fulton, J. J. Capt. Mad. Staff Corps
Furlong, Geo. W. Capt. 21st R. N. B. Fus. (1*l.*)
Furlong, J. S. M D. Surg 6th Inns. Drs (1*l.*)
*Fyers, Henry Thomas Major h.p. R.A. Col. E. and N. York Art. Mil. (1*l.*)

GAGE, E. Major late Sco. Fus. Gds.
Gage, *Hon.* E. T. Col. Roy. Art. (1*l.*)
Gage, *Hon.* H. E. Hall Lt.-Col. R. Sussex L. I. Mil. (1*l.*)
Gage, VISCOUNT Major late Sus. Mil. (1*l.*)
Galbraith, W. Lieut. 85th K. L. I. (1*l.*)
Galloway, T. J. Maj.-Gen.
Galton, Douglas Capt. (ret.) R.E Asst. Under Secretary of State for War, F R.S.
Gambier, Gloucester, CB Col. R H.A.
Gammell, A. Major late 43rd Regt.
Gammell, J. H. H. Capt. 9th Regt. (1*l.*)
Gardiner, R. Col. I. F. O. Glasgow (1*l.*)
Gardiner, T. Esq. late Purser H. E. I. C. S. (1*l.*)
Gardiner, W. Commr. R.N
Gardner, G. H. Capt. R.N. (1*l.*)
Gardner, W. B. Col. Roy. Art (1*l.*)
Gardyne, C. Greenhill Capt. Coldm. Gds.
Garforth, Wm. Commr. R.N. (1*l.*)
Garlies, Adam P. LORD Capt R. H. Gds.
Garnett, A. P. Capt. 11th Hussars
Garratt, J A. T. Lieut Gr. Gds. (1*l.*)
Garrett, Francis Capt. late 3rd Drag. Gds. Lieut. Royal 1st Devon Yeom Cav. (1*l.*)
*Garsia, M. C. Lieut. 56th Regt. (1*l.*)
Garstin, R. L. Col. (ret.) R.A.
Garvock, John Col. h.p. 31st Regt Brig. Gen. Shornclifte
Gascoigne, Chas. Lieut.-Gen. Col. 89th Regt (1*l.*)
Gascoigne, Clifton Capt. Gr. Gds. (1*l.*)
Gascoigne, Ernest F. Lieut.-Gen. Col. 69th Regt. (1*l.* 1*s.*)
Gascoigne, W. Lieut. Sco. Fus. Gds. (1*l.*)
Gawler, Geo. KH. Col. late of 52nd L. I. (1*l.*)
Gearey, H. L. Capt. R.A. (1*l.*)
George, Christopher Commr. R.N (1*l.*)
George, F. D. CB. Col. unatt. (1*l.*)
George, G. T. Lieut.-Col. late Paym. 4th Huss.
German, James Capt. 3rd Roy. Lan. Mil. (1*l.*)
Gibb, Charles John Lieut.-Col. R.E.

Gibbings, Thos. Lt.-Col. (ret.) 2nd W. I. Regt. (1*l.*)
Gibbon, Arthur, Esq. Acct.-Gens. Branch, War Office (1*l.*)
*Gibbons, Charles Commr. R.N. (1*l.*)
Gibbons, John Surgeon 95th Regt.
Gibbs, Charles Capt. 2nd Queen's (1*l.*)
Gibson, Charles E. Capt. 3rd Regt. or Buffs
Gibson, Edgar Lieut.-Col. unatt.
Giffard, Edw. Esq. Admiralty
Gilbard, Geo. J. Capt. 13th Huss. (1*l.*)
Giles, John C. Captain R.N.
Gilford, Viscount Capt. R.N. (1*l.*)
Gill, T. Mc N. Lieut. 13th Lt. Inf. (1*l.*)
Gilmore, A. H. Lieut. R.N. (1*l.*)
Gilmour, C. D. Capt. R.A.
Gilpin, Rich. T. Col. Bedford. Mil. MP.
Gipps, F. B. Lieut. 35th Roy. Sussex Regt. (1*l.*)
Gipps, H. Capt. 9th Regt.
Gipps, Reginald Lt.-Col. Sco. Fus. Gds.
Gledstanes, H. B. Lieut. 75th Regt. (1*l.*)
Gleig, A. C. Lieut.-Col. R.A. Asst. Insp. of Schools
Gleig, C. E. S. Bt.-Major h.p. 14th Regt.
Gleig, *Rev.* G. R. M.A. Chaplain-General to the Forces (1*l.*)
Glover, Stirling F. Lt.-Col. late 12th Regt.
Glyn, Rich. G. Capt. late 1st R. Drags.
Godbold, G. B. Capt. Adj. 1st Batt. Renfrewshire Rifle Vols.
Godley, W. A. Capt. 56th Regt. (1*l.*)
Godson, Chas. Asst.-Surg. Edmonton R. Rifles
Godwin, A. A. Lieut. 103rd Roy. Bomb. Fus.
Godwin—Austen H. H. Capt. Beng. Staff Corps (1*l.*)
Goff, Robert Charles Capt. 15th Regt. (1*l.*)
Goff, Thos. Wm. Capt. late 7th Drag. Gds. M.P. (1*l.*)
Gold, W. Geo. Major-Gen. (1*l.*)
Goldney, *Rev.* J. K. MA. Chaplain R.N. (1*l.*)
Goldsmith, George, CB. Rear-Adm. (1*l.*)
Goldsworthy, W. T. Capt. 91st Highlrs. (1*l.*)
Gomm, *Sir* Wm. M. GCB. Gen. Col. Colds. Gds. (1*l.*)
Gooch, H. Lieut.-Col. late Colds. Gds. (1*l.*)
Good, James Staff Asst. Surg.
Goode, W. H. Major late 62nd Regt. (1*l.*)
Goodenough, W. H. Major R.A. (1*l.*)
Goodfellow, W. B. Major-Gen. R.E.
Goodlake, G. L. V.C. Lt.-Col. Coldm. Gds.
Goodliffe, F. G. Lieut. Lond. Rifle Brigade Vols. (1*l.*)
Goodsman, David Lieut.-Gen. (2*l.*)
Goolden, G. B. Lieut. R.N.
Goose, William Capt. R.N. (1*l.*)
Gordon, *Sir* Jas. A. GCB. Admiral (1*l.*)
Gordon, *Hon.* Alex. CB. Major-Gen. (1*l.*)
Gordon, F. A. Ens. 60th Royal Rifles (1*l.*)
Gordon, G. Grant Lieut.-Col. Sco. Fus. Gds.
Gordon, George Hamilton Capt. R.E. (1*l.*)
Gordon, H. W. Col. Comm. Lieut.-Gen. R.A.
Gordon, Henry W. Esq. CB. Principal Superintendent of Stores, Woolwich
Gordon, *Hon.* John Admiral
Gordon, John Lieut.-Col. late 47th Regt. (1*l.*)
Gordon, J. S. Capt. 3rd Buffs (1*l.*)
Gordon, Robt. Rear-Adm. (1*l.*)
Gordon, William Vice-Adm.
Gore, *Hon. Sir* Charles, KCB. KH. Gen. Col. 6th Regt.
Gore, W. R. O. Major late 13th Light Drs.
Gorges, A. H. Lieut. R. H. Art. (1*l.*)
Gosling, Geo. Lieut. Sco. Fus. Gds. (1*l.*)
Gosselin, Nicholas Lieut. (ret.) 23rd R. W. Fus. (1*l.*)
Gosset, Charles Lieut. R.N.
Gosset, H. Allen Lieut. Paym. 75th Regt. (1*l.*)
Gossett, W. D. Lieut.-Col. R.E. (1*l.*)
Gough, Hugh, Viscount, KP. GCB. KSI. Field-Marshal, Col. Royal Horse Guards
Gough, Hugh Capt. late 1st Royal Drags.
Goulburn, Edward Col. late Gren. Gds.
Gould, F. A. Lt.-Col. late 2nd Drags. (1*l.*)
Gould, Henry O. Capt. Gren. Gds. (1*l.*)
Gould, T. T. Lieut. 13th Light Infantry (1*l.*)
Gower, Erasmus Capt. 12th Royal Lans.
Græme, C. H. Major-Gen. (ret.) H.M. Indian Army
Græme, *Rev.* G. Mil. Chap. H.E.I.C. Ser. (1*l.*)
Graham, Allan Capt. Renfrewshire Rifle Vols. (1*l.*)
Graham, Allan Ham. Col. R.A.
Graham, Gerald Lieut.-Col. Roy. Eng. (1*l.*)
Graham, H. A. Lieut. late 7th Fus. (1*l.*)
Graham, Jas. John Col. Staff Officer of Pensioners, Regent's Park Barracks
Graham, Lumly Lt.-Col. 19th Regt. (1*l.*)
Graham, T. P. Lieut. Sco. Fus. Gds. (1*l.*)
Grahame, Francis Barclay Lt. late Forfar and Kincardine Mil.
Grahame, Geo. Quar. Mastr. 21st R. N. B. Fus.
*Grange, Chas. Walter Major R. Can. Rifles
Grant, Edward Fitzherbert Col. (ret.) R.A.
Grant, Geo. Fox Lieut. 62nd Regt. (1*l.*)
Grant, *Sir* James Hope Lieut-Gen. GCB. Col. 4th L. Drag. (1*l.*)
Grant, John Capt. (ret.) R.A. (1*l.*)
Grant, John M. Capt. R.E. (1*l.*)
Grant, J. M. Lieut. 85th K. L. I.
Grant, J. Thornton, CB. Col. 18th Regt.
Grant, J. W. Surg. (ret.) Bengal Army (1*l.*)
Grant, Wm. Lieut. 91st Highlanders
Grant, W. F. Col. (ret.) Bengal Army (1*l.*)
Grant, W. L. Lt.-Col. K. O. Lt. Inf. Mil.
Granville, B. Maj. 2nd Warwick Mil. (1*l.*)
Gratton, A. O. D. Lieut.-Col. R.E. (1*l.*)
Gray, Basil Capt. unatt. (1*l.*)
Gray, W. J. Capt. R.A. (1*l.*)
Graydon, Geo. Col. Roy. Art. (1*l.*)
Greathed, E. H. CB. Col. unatt. (1*l.*)
Greathed, W. W. H. CB. Lt.-Col. R.E. Bengal. Asst. Mil. Secretary (1*l.*).
Greaves, R. Lieut.-Gen. Col. 40th Regt.

Green, Andrew Major, Rifle Brigade
Green, Edwd. Major-Gen. Bombay Staff Corps
Green, G. F. Ens. 14th Regt.
Green, M. S. CB. Major H.M. Bomb. Arm. (1*l.*)
Green, W. H. R. CB. Major H.M. Bomb. Army (1*l.*)
Greene, C. Capt. R.N.
Greenfield, J. T. Lieut. R.A. (1*l.*)
*Greenwood, J. Major 5th Boy. Lan. Militia (1*l.*)
Greenwood, Wm. Lt.-Col. late Gren. Gds.
Greer, Arthur J. Surg. 21st R. N. B. Fus. (1*l.*)
Greer, H. Harpur Col. 68th Lt. Inf.
*Gregory, C. H. Capt. Commt. 1st Tower Hamlets Eng. Vols. (1*l.*)
Gregory, E. F. Capt. 98th Regt. (1*l.*)
Gregson, J. D. Ens. 40th Regt. (1*l.*)
Greville, A. C. Lt.-Col. unatt. (1*l.*)
*Grey, Francis D. Lt.-Col. 37th Regt.
Grey, *Hon. Sir* Fred. W. KCB. Vice-Adm. Lord of the Admiralty
Grey, *Hon.* George Vice-Admiral
Grierson, Crighton Lieut.-Gen. (ret.) R.E.
Griffith, Julius G. Lt.-Gen. Col. Com. R.A. Bombay
Griffith, J. G. T. Capt. R.E. (1*l.*)
Griffiths, E. St. J. Capt. 19th Regt. (1*l.*)
Griffiths, Fred. Aug. Major (ret.) R.A. (1*l.*)
Griffiths, Leonard Capt. R.A. Prof. of Fortification Roy. Mil. Col. Sandhurst (1*l.*)
Grimston, Walter J. Capt. R.A. (1).
Grosvenor *Hon.* R. W. Capt. 1st Life Gds.
Grove, W. C. Lieut. Colds. Gds. (1*l.*)
Grover, G. E. Lieut. R.E. (1*l.*)
Gubbins, Jas. Lt.-Col. 23rd R. W. Fus. (1*l.*)
Guest, Montagu J. Cor. Dor. Yeo. Cav. (2*l.*)
Guise, J. C. Col. (ret.) 90th L. Inf.
Guise, *Sir* J. W. *Bart.* GCB. Gen. Col. 85th L. Inf.
Gunning, W. Capt. late 52nd L.I.
Guy, Philip M. Nelson, CB. Major-Gen. Commanding Troops in China (1*l.*)

HAGGARD, W. M. R. Capt. East Norfolk Mil.
Haig, C. T. Capt. R.E. (1*l.*)
*Haig, John F. Lieut. 90th L.I. (1*l.*)
Haines, F. P. Major-General
Haldane, G. H. J. Capt. 64th Regt. (1*l.*)
Haliburton, Alex. F. Capt. late Lanc. Yeo. Cav. (1*l.*)
Halkett, J. Lt.-Col. (ret.) Colds. Gds.
Halkett, Peter A. Lieut. R.N.
Hall, A. W. Capt. and Adj. 6th Dep. Batt.
Hall, E. C. Lieut. R.N. (1*l.*)
Hall, George Lt.-Col. late 54th Regt. (1*l.*)
*Hall, George Lt.-Col. Durham Mil. Art. (1*l.*)
Hall, John Lieut.-Gen.
*Hall, John P. Maj. Paym. 22nd Dep. Batt. (1*l.*)
Hall, Julian H. Capt. Colds. Gds.
Hall, Lewis Alex. Lieut.-Gen. Col. Commt. R.E.
Hall, R. M. Capt. 13th Light Inf. (1*l.*)
Hall, Robert Capt. R.N. (1*l.*)
Hall, William H. CB. Rear-Adm.
Hall, Wm. King Capt. R.N. (1*l.*)
Hallett, J. A., Esq. Navy Agent (1*l.*)
Hallewell, C. J. M. Lieut. 19th Regt. (1*l.*)
Hallewell, E. G. Col. unatt. Commt. Roy. Mil. College
Hallowes, John Rear-Adm. (1*l.*)
Halsted, E. P. Rear-Adm. (1*l.*)
Halsted, G. A. Capt. R.N. (1*l.*)
Halsted, Lawrence W. Lieut. 16th Mad. N.I.
Halton, Lancelot Major late 16th Lancers
Haly, W. O. Grady, CB. Col. 38th Regt.
Hamersley, Jas. Lieut. 22nd Regt.
Hamilton, A. Terrick Capt. late 71st Highd. Lt. Inf. (1*l.*)
Hamilton, A. C. Lieut. Roy. Engrs.
Hamilton, Chas. CB. Maj.-Gen. Col. Beng. N. I. (1*l.*)
Hamilton, Lord Claud Lieut.-Col. Donegal Mil. (1*l.*)
Hamilton, *Sir* Edw. A. *Bt.* Lt. Colds. Gds. (1*l.*)
Hamilton, Fred. Wm. CB. Major-Gen. Vice.-Pres. of Council of Mil. Educ. (1*l.*)
Hamilton, J. Glencairn C. Capt. late 2nd Life Guards (1*l.*)
Hamilton, L. H. Lieut.-Col. 87th R. I. Fus. (1*l.*)
Hamilton, Robert George Col. R.E.
Hamilton, R. W. Lt.-Col. Gren. Gds. (1*l.*)
Hamilton, Terrick, Esq.
Hamilton, W. H. Paym. R.N. (1*l.*)
Hamilton, W. D. Maj. late 13th Lt. Drs. (1*l.*)
Hamley, E. B. Col. R.A. (1*l.*)
Hammersley, Chas. Esq. Army Agt. (1*l.*)
Hammersley, Fred. Major unatt. (1*l.*)
Hammond, Fred. Col. (ret.) 66th Regt.
Hamond, *Sir* Andrew S. *Bart.* Capt. R.N.
Hamond, H. E. Lieut. late 1st Life Gds.
Hanby, Jos., Esq. late War Office (1*l.*)
Hancock, Geo. Capt. R.N.
Hancock, H. J. B. Ens. late 45th Regt. (1*l.*)
Handy, B. F. Lieut. 8th or King's
Hankey, F. A. Capt. Queen's Westr. Rifle Vols. (1*l.*)
Hanmer, Wyndham E. Major late 6th Drags.
Hanna, H. B. Lieut. 19th Beng. Cav.
Hanwell, Joseph Maj. Gen. (ret.) R.A.
Harcourt, F. Venables Col. late Colds. Gds. (1*l.*)
*Harding, Francis Pym, CB. Col. 22nd Regt. (1*l.*)
*Hardinge, C. S. Viscount Lieut.-Col. Kent Rifle Vols. (1*l.*)
Hardinge, *Hon.* A. E. CB. Col. Colds. Gds.
Hardwicke, C. Philip, *Rt. Hon.* Earl of Admiral (1*l.*)
Hardy, F. Capt. 84th Regt. (1*l.*)
Hardy, John Capt. 9th Lancers (1*l.*)
Hardy, J. S. Lieut. Rifle Brigade (1*l.*)
*Hare, E. H. Lieut. 11th Regt. (1*l.*)
Hare, *Hon.* Richard Lt.-Col. late 90th Regt.
Hare, *Sir* T. *Bart.* Capt. late 2nd Life Gds.
Harford, F. H. Lieut. Sco. Fus. Gds. (1*l.*)
Harison, O. Ens. 5th Fusiliers

Harkness, G. Capt. 5th Fus.
Harmar, D. J. Standard Bearer H.C.G. Arms
Harness, Henry Drury, CB. Col. R.E.
*Harnett, Edward Capt. 11th Huss. (1*l.*)
Harrington, J. Dep. Purv. late Army Med. Dep. (1*l.*)
Harrington, R. E. S. Capt. Rifle Brigade (1*l.*)
Harris, *Hon.* Edward A. J. CB. Rear-Adm.
Harrison, Geo. Alex. Capt. 79th Highrs.
Harrison, R. Capt. R.E. (1*l.*)
Harrison, W. A. Ass.-Sur. Hants Mil. Art. (1*l.*)
Hart, Hen. Geo. Col. unatt. (1*l.*)
Hartley, James Lieut. 5th Fus. (1*l.*)
Hartley, R. W. Capt. late 94th Regt. (1*l.*)
Hartman, G. A. Capt. 13th Light Inf. (1*l.*)
Hartopp, W. W. Capt. R. Horse Guards
Harty, Jos. Mark Col. (ret.) 33rd Regt. (1*l.*)
Harvey, Chas. Elwin Capt. R.E.
Harvey, C. Lacon Lieut. 91st Highrs. (1*l.*)
Harvey, John Col. unatt. (1*l.*)
*Harwood. Ed. Major 2nd Som. Mil. (1*l.*)
Harwood, J. A. P. K. Lieut. 13th Light Inf. (1*l.*)
Haskoll, William Capt. R.N. (1*l.*)
Haslett, A. K. Lieut. R.E. (1*l.*)
Hastings, *Hon.* G. F. CB. Rear-Adm.
Hastings, *Sir* Thomas, KCB. Vice-Admiral
Hatherton, LORD Col. 2nd K. O. Staff Mil.
Hathorn, Geo. Rear-Adm. (1*l.*)
Hatton, E. H. F. Capt. late Northampton Mil. (1*l.*)
Hatton, Villiers Latouche Lt.-Col. late Gr. Gds. (1*l.*)
Havelock, *Sir* Henry, *Bart.* G.C.B. Brevet Lt.-Col. unatt. Dept.-Asst. Adj. Gen. New Zealand (1*l.*)
Hawkins, F. K. Commander R.N. (1*l.*)
Hawkins, H. C. Commander R.N.
Hawkins, Major R. Capt. Queen's West. Rifle Vols. (1*l.*)
Hawley, W. H. Major 14th Regt. (1*l.*)
Hay, LORD Arthur Col. Gr. Gds.
*Hay, C. C. Maj.-Gen. Com. Sch. of Musk. Col. 58th Regt. (1*l.*)
Hay, *Hon.* C. R. Lt.-Col. Sco. Fus. Gds.
Hay, Graham Capt. 62nd L. I. (1*l.*)
Hay, *Rt. Hon.* LORD John, CB. Capt. R.N.
*Hayes, John Montague Capt. R.N. (1*l.*)
Hayne, Rich. Capt. late h.p. R.S.C. (1*l.*)
Hayter, A. D. Capt. Gren. Gds.
Hayward, H. B. Capt. 45th Regt. (1*l.*)
Heaslop, J. C. Capt. R.N. (1*l.*)
Heath, Edwin Lieut. h.p. 88th Regt.
Heath, H. G. Ens. 18th Royal Irish
Heath, Leopold G. CB. Capt. R.N. (1*l.*)
Heathcote, C. T. Capt. Bomb. Staff Corps (1*l.*)
Heathcote, Eustace Major Hants Mil. (1*l.*)
Heathcote, J. A. Lieut. H.M. Indian Navy (1*l.*)
Hemmans, Thos. Hinton Lt.-Col. (ret.) 78th Highs.
Henderson, E. Y. W. Lieut.-Col. R.E. (1*l.*)
Henderson, W. Col. R.A.
Heneage, C. W. C.B. Major 8th Huss. (1*l.*)
Heneage, E. Lieut. (ret.) 1st Life Gds.
Hennell, S. Col. (ret.) Bombay Army (1*l.*)
Henningen, *Sir* R. Capt. late Field Train
Henry, G. C. Major R. H. Artillery
*Henslowe, S. V. F. Capt. 73rd Regt. (1*l.*)
Hepburn, Henry P. Col. Sco. Fus. Gds. (1*l.*)
Herbert, Arthur Col. unatt. (1*l.*)
Herbert, C. J. Capt. Gren. Gds. (1*l.*)
Herbert, H. A. Capt. Cold. Gds.
Herbert, J. B. Esq. late Mil. Sec.
Herbert, *Hon.* Percy E. CB. Col. Dep. Qua.-Mas. Gen.
Herbert, R. W. H. Lieut. R.N.
Herbert, *Hon.* W. H. Capt. 84th Regt. (1*l.*)
Herringham, W. A. Vice-Admiral
Hewett, W. N. W. C.B. Capt. R.N. (1*l.*)
Heyland, A. H. Ens. 65th Regt. (1*l.*)
Heythuysen, Geo. Van. Ens. 14th Regt. (1*l.*)
Heywood, J. M. Capt. R.E. Bengal
Heywood, Wm. Capt. 14th Regt. Major of Brigade New South Wales (1*l.*)
Hibbert, J. Nembhard Major late 97th Regiment
Hichens, Wm. Capt. R.E. (1*l.*)
Higgins, T. Gordon Major-Gen. R.A. (1*l.*)
Higgins, W. F. Esq. late Clerk in Colonial and War Departments (1*l.*)
Higginson, G. P. Lt.-Gen. Col. 94th Regt.
Higginson, G. W. A. Col. Gr. Gds. (1*l.*)
Hight, Edward Lieut. R.N.R. (1*l.*)
Hill, Edwd. Rowley Major-General
Hill, *Hon.* Geoffroy R.C. Capt. (ret.) R.H. Gds.
Hill, Geo. Staveley Capt. N. Salop Yeo. Cav.
Hill, Henry Capt. and Adj. Chesh. Yeo. (1*l.*)
Hill, John Major-Gen. R.A.
Hill, John Thomas Major-Gen.
Hill, Rt. J. Lt. late 1st Royals (1*l.*)
Hill, Stephen J., CB. Col. (ret.) 3rd Lt. Drs. Capt. Gen. and Com.-in-Chief, Sierra Leone (1*l.*)
Hill, W. Lt.-Col. 2nd W. I. R. (1*l.*)
Hinchingbrook, VISCOUNT Capt. Gr. Gds.
Hind, Chas. Col. 6th W. York Mil.
Hinde, John, CB. Col. 8th or King's (1*l.*)
Hinton, F. Major 1st Dorset Art. Vols.
Hirst, R. A. H. Major late W. Essex Mil. (1*l.* 1*s.*)
Hobart, *Hon.* H. M. Capt. 103rd Royal Bomb. Fus. (1*l.*)
Hodgson, W. C. Lieut.-Col. 79th Highlanders (1*l.*)
Hogarth, Joseph Lieut. 43rd L. Inf.
Hogg, J. M'Naghten Lt.-Col. late 1st Life Gds. (1*l.*)
Hogg, T. D. Capt. 1st Devon Mil.
Hogge, C. Neville Lt.-Col. Gren. Gds.
Holburne, *Sir* Thos. Wm. *Bart.* Commr. R.N. (1*l.*)
Holcombe, F. Major (ret.) R.A.
Holden, Henry Lieut.-Col. late 13th Light Drgs. (1*l.*)
Holder, Charles Lieut.-Col. (late) Sco. Fus. Gds.

Holford, H. P. Lieut. (ret.) 10th Royal Huss. (1*l.*)
Hollist, E. O. Lieut. R.A. (1*l*).
Holmes, H. R. Lieut. R.N. (1*l.*)
Holmes, W. H. M. Capt. late R. Lond. Mil.
Holmesdale, VISCOUNT Capt. late Colds. Gds. (1*l.*)
Holroyd, Geo. S. Lieut. 73rd Regt. (1*l.*)
Holt, Alfred Capt. 21st R. N. B. Fus. (1*l.*)
*Holt, John Capt. H.M. 20th Bombay N.I. (1*l.*)
Home, D. M. Cornet R. H. Gds. (1*l.*)
Home, Robert Capt. R.E.
Home, *Hon.* W. S. D. Capt. Gren. Grds. (1*l.*)
Hood, *Hon.* A. Nelson Major-Gen.
Hood, F. W. VISCOUNT Lt.-Col. (ret.) Gr. Gds. (1*l.*)
Hood, J. Phipps, Esq. late Registrar Vice-Admiralty Court, Halifax
Hood, W. C. Lieut. 2nd Queen's Royals
Hood, W. H. Commr. R.N.
Hook, H. H. Lieut. 45th Regiment (1*l.*)
Hooper, F. E., Esq. Med. Dept. Som. House (1*l.*)
Hope, Chas. Wm. Capt. R.N. (1*l.*)
Hope, Fras. Capt. late R.A. (1*l.*)
Hope, Fred. Major-Gen.
Hope, H. P. Esq. late Mate R.N. (1*l.*)
Hope, H. W. Capt. Gren. Gds.
Hope, John E. Major R.A. (1*l.*)
Hopkins, J. O. Commr. R.N. (1*l.*)
Hopkinson, C. Esq. Army Agent
Hopkinson, Wm. Capt. London Rifle Brig. Vols. (1*l.*)
Hopwood, Hervey Col. late Gren. Gds.
Hore, E. G. Capt. R.N. (1*l.*)
*Horne, E. G. Capt. 25th Regt. (1*l.*)
Horner, John Capt. (ret.) 58th Regt.
Horner, John Capt. late 55th Regt.
Horsford, *Sir* Alfred H. KCB. Col. Depy. Adj.-Gen. to the Forces (1*l.*)
*Hort, J. J. Col. 36th Regt. (1*l.*)
Horton, George W. Col. late 7th Dr. Gds. (1*l.*)
Horton, William Capt. R.N. (1*l.*)
Hoseason, J. C. Captain R.N. (1*l.*)
Hoste, *Sir* William, *Bart.* Capt. R.N.
Hotham, Beaumont LORD Lieut.-Gen., M.P.
Hotham, B. W. Capt. late Gr. Gds. (1*l.*)
Howard De Walden, C. A. LORD, GCB. Capt. h.p. 8th Foot
Howe, EARL Lt.-Col. Leicester Yeo. (1*l.*)
Howes, Geo. Capt. R.N. (1*l.*)
Hozier, H. M. Lieut. 2nd Life Gds. (1*l.*.
Hozier, John Wallace Lieut. 2nd. R. N. B. Drags. (1*l.*)
Hudson, John Capt. R.N.
Huggins, John Ens. 20th Middlesex R. Vols. (1*l.*)
Hughes, C. A. Cornet 2nd Life Gds.
Hughes, Charles Col. (ret.) 24th Regt.
Hughes, J. W. Lieut. 8th or King's (1*l.*)
Hughes, T. de Bashall Lieut. (ret.) Cape M. Rifles
Hughes, W. J. M. Capt. late 1st Dragn. Gds. (1*l.*)
Humby, G. Capt. late Q.O.L.I. Mil. (1*l.*)
Hume, Henry, CB. Col. (ret.) Gren. Gds. (1*l.*)
Humfrey, C. A. Lt. 92nd Highlndrs. (1*l.*)
Humphrys, A. W. Ens. 8th or King's
Hunt, H. B. Master R.N. (1*l.*)
Hunter, Edw. Capt. 62nd Regt. (1*l.*)
Hunter, R. S. Capt. late 6th Drgn. Gds.
Hunter, T. MD. Deputy Insp. Gen. of Hospitals
Hunter, T. R. Lieut. Indian Navy (1*l.*)
Huskisson, J. W. Lieut. 56th Regt. (1*l.*)
Hutchinson, C. H. Lt.-Col. R. A. Madras
Hutchinson, C. S. Capt. R.E. Prof. of Fort. Roy. Mil. Academy, Woolwich (1*l.*)
Hutchinson, *Hon.* H. Hely Col. late 6th Dr. (1*l.*)
Hutchinson, John Lt.-Col. 8th Lan. Volrs. (1*l.*)
Hutchinson, W. Nelson Major-Gen. Col. 33rd Regt. commanding Western District (1*l.*)
Hutchison, H. McL. Lt. 14th Regt. (1*l.*)
Hutton, C. W. Capt. 59th Regt. (1*l.*)
Hutton, F. W. Capt. 23rd R. Welch Fus. (1*l.*)
Hyde, G. Hooton Major-Gen. (ret.) R.A.

IBBETSON, Chas. Parke Lt.-Col. h.p. 89th Regt.
Ind, F. J. N. Capt. 37th Regt.
*Ingall, W. L., CB. Col. 62nd Regt.
Inglefield, E. A. Captain R.N. (1*l.*)
Inglefield, S. H. S. Lt.-Col. (ret. h.p.) R.A. (1*l.*)
Inglis, C. D. Lieut. R.N. (1*l.*)
Inglis, Thos. Capt. Royal Engineers (1*l.*)
*Inglis, Wm. Col. 18th Depôt Batt. (1*l.*)
Ingram, Aug. H. Capt. R.N. (1*l.*)
Irby, J. J. C. Capt. Adj. Chelsea Hosp. (1*l.*)
Isacke, Rob. J. Lieut. 71st Highd. Light Inf.
Ives, C. R. St. J. Cornet R. H. Gds.
Ives, G. M. Lieut. late Colds. Gds.

JACKSON, F. G. Lieut. 21st R.N.B. Fus. (1*l.*)
Jackson, J. M. Commr. R.N.
Jackson, Randle Lieut. 32nd L. I. (1*l.*)
Jackson, R. Æmilius Commr. R.N. (1*l.*)
Jacob, Geo. Thompson Capt. late 4th Drag. Gds. (1*l.*)
James, Edm. R. Capt. R.E. (1*l.*)
James, *Sir* Henry Colonel R.E. Director Topographical Dept.
James, J. W. Commr. R.N. (1*l.*)
James, T. Lt.-Col. (ret.) Indian Army (1*l.*)
Jameson, R. O'Brien Capt. late 11th Hus.
Jarrett, C. B. Capt. Gr. Gds.
Jarvis, J. Geo. Capt. late 52nd L.I.
Jay, Jno. Livingstone, Esq. Sec. to Governr. Greenwich Hospital (1*l.*)
Jay, W. C. Capt. Hon. Art. Compy. (1*l.*)
Jebb, Fredk. W. Major 67th Regt. (1*l.*)
Jefferis, John Lieut. (ret.) Madras Art. (1*l.*)
Jefferson, R. Capt. Paym. h.p. Ceylon Rt.
Jeffreys, Edmd. R. CB. Col. 5th Dep. Bn.

Jekyll, E. Capt. late Gr. Gds. (1*l.*)
Jelf-Sharpe, Henry Lt.-Col. Sco. Fus. Gds.
Jennings, Peter Raymond Lt.-Col. (ret.) 13th Lt. Inf.
Jennings, T. T. Paymaster R.N. (1*l.*)
Jephson, J. H., MD. late Asst.-Surg. 49th Regt.
Jervis, E. S. Capt. 106th Bom. Light Inf. (1*l.*)
Jervis, H. J. W. Capt. R.A.
Jervis, W. S. Lieut. 101st Roy. Beng. Fus. (1*l.*)
Jervois, E. S. Capt. h.p. 7th Roy. Fus. (1*l.*)
Jervois, W. F. Drummond Lt.-Col. R.E. Asst. Insp.-Gen. of Fortifications (1*l.* 1*s.*)
Jervoise, H. C. Capt. Colds. Gds. (1*l.*)
Jobling, F. C. Ens. Ceylon Rifles (1*l.*)
Jocelyn, *Hon.* A. G. F. Maj. late 95th Regt. (1*l.*)
Jocelyn, *Hon.* J. Strange Lieut.-Col. late Sco. Fus. Gds. (1*l.*)
Joddrell, F. C. Capt. late Gr. Gds.
Johnson, Clement Capt. late 60th Royal Rifles
Johnson, Edm. Geo. Capt. Rifle Brig. (1*l.*)
Johnson, Ger. John Capt. late 11th Huss.
Johnson, Rob. Capt. 2nd R. Lanc. Rifles (1*l.*)
Johnson, W. V. Capt. late 90th L.I.
Johnston, H. H. Cornet 9th Queen's Royal Lancers (1*l.*)
Johnston, Thos. H. Lt.-Gen. Col. 87th R. I. Fus.
Johnston, W. F. Col. late Gr. Gds.
Johnstone, Fred. E. Commr. R.N. (1*l.*)
Johnstone, *Hon.* H. Butler Major, Scottish Borderers Mil. (1*l.*)
Jolliffe, Hylton Hedworth Capt. N. Som. Yeo. Cav. late Colds. Gds.
Jones, A. F. V.C. Capt. 4th Huss. (1*l.*)
Jones, Alfred S. Major 13th L.I. (1*l.*)
Jones, D. G. Lieut. R.E. (1*l.*)
Jones, E. M. Capt. 20th Regt. (1*l.*)
Jones, George Capt. late Montgomery Mil.
Jones, G. P. R. Capt. Queen's Own L.I. Mil.
Jones, *Sir* Harry D. GCB. Gen. Col. Commandant R.E. (1*l.*)
Jones, Inigo W. Col. late unatt. Lieut.-Col. Som. Rifle Volunteers
Jones, John Lieut. 8th or King's
Jones, *Sir* John, KCB. Col. I.F.O. Liverpool
Jones, Josiah Capt. 12th Lan. Art. Volrs. (1*l.*)
Jones, *Sir* Lewis T. KCB. Rear-Adm. (1*l.*)
Jones, Loftus F. Commr. R.N. (1*l.*)
Jones, Wm. Capt. late 14th Lt. Drags.
Jopp, A. A. Lieut. R.E. (1*l.*)
Julian, T. A. Capt. 52nd Light Inf. (1*l.*)

KAIN, Geo. James, Capt. 1st Middx. Eng. Volrs. (1*l.*)
Kaye, Wilkinson Lister Capt. h.p. R.A.
Keane, G. M. Lt.-Col. (ret.) 2nd Queen's (1*l.*)
Keane, Hon. H. F. Lt.-Col. Royal Engrs.
Kearney, Chas. Lt.-Col. late 2nd Drag. Gds.
Keate, R. W. Esq. Gov. of Trinidad (1*l.*)
Keating, James Singer Lieut.-Col. late Rifle Brigade (1*l.*)
Kebbel, W. H. Capt. Roy. Arsenal Rifle Vols.
Keirle, R. Lieut. 1st Middlesex Art. Volrs. (1*l.*)
Kellett, Henry, CB. Rear-Admiral
Kelly, John Major (ret.) 6th Regt.
Kelly, J. L. Capt. 10th Regt. (1*l.*)
Kelly, *Sir* R. D., KCB. Col. (ret. h.p.) 34th Regt. (1*l.*)
Kelly, Rd. S. Capt. and Barrack Master Hythe h.p. R.S. Corps.
Kelly, W. D. Lieut. late Roscommon Mil.
Kelsall, Henry Capt. 16th Regt. (1*l.*)
Kempt, John F. Col. 12th Regt. (1*l.*)
Kenah, Thomas, CB. Gen. Col. 63rd Regt.
Kendrick, H. Esq. late War Office
Kennard, E. H. Lieut. 8th Huss. (1*l.*)
Kennedy, G. R. H. Col. R. A. (1*l.*)
Kennedy, J. Clarke, CB. Col. Commt. Mil. Train (1*l.*)
Kennedy, J. J. Ens. 10th Regt.
Kennedy, J. P. Bt. Lt.-Col. h.p. 42nd Regt. (2*l.*)
Keppel, *Hon. Sir* H. KCB. Rear-Adm. (1*l.*)
Kerr, LORD Mark, CB. Col. 13th Lt. Inf.
Kerr, R. D. LORD Capt. 10th Huss. (1*l.*)
Kerr, Robert Dundas Capt. R.E. (1*l.*)
Key, Geo. Wm. Maj.-Gen. Com. Cav. Brig. Curragh
Keyworth, J. W. Lieut. 48th Regt.
Kidd, John M. Lt.-Col. late 87th Fus.
Kidston, A. F. Lieut. 42nd Roy. Highrs. (1*l.*)
Kilcoursie, VISCOUNT Lieut. R.N. (1*l.*)
King, Edw. R. Col. late 36th Regt.
King, George Major-General (ret. f.p.) 13th Lt. Inf.
King, Geo. S. MD. Surg. 96th Regt. (1*l.*)
King, Geo. St. Vincent, CB. Rear-Adm. (1*l.*)
King, H. B. Commr. R.N. (1*l.*)
King, H. J. Major (ret.) 3rd Buffs. (1*l.*)
King, John R. Capt. Roy. Art.
King, J. Hynde Col. Gren. Gds. (1*l.*)
King, R. Thos. Lieut.-Gen. R.A. (1*l.*)
King, W. G. N. Capt. R.N. (1*l.*)
Kingscote, R. N. F. CB. Lt.-Col. late Scots. Fusilier Guards
Kingston, A. B. Lieut. R.N.
*Kingston, Aug. J. Commr. R.N. (1*l.*)
Kinloch, Alex. Capt. late Gren. Gds.
Kirby, Chas. F. Maj. Adj. 7th Middlx. Rifle Volrs. (1*l.*)
Kirby, W. H. Lt.-Col. 94th Regt. (1*l.*)
*Kirk, James B. 96th Regt. (1*l.*)
*Kirkland, J. A. Vesey Col. 5th Fus.
Kirkwall, G. W. H. VISCOUNT Capt. late Sco. Fus. Gds.
Kirwan, Chas. Jno. Staff Asst.-Surg.
Kitchen, Edw. Capt. late H. A. C.
Kitchener, H. Lieut. 6th Regt. (1*l.*)
Knight, H. S. Capt. 19th Regt. (1*l.*)
Knight, W. H. Capt. 48th Regt. (1*l.*)
Knobel, Wm. Roberts Capt. Essex Rifles (1*l.*)

Knollys, W. T. Lieut.-General Col. 62nd Regt. (1*l.*)
*Knollys, W. W. Capt. 93rd Highlds. (1*l.*)
Knowles, C. B. Lieut. 67th Regt. (1*l.*)
Knox, *Hon.* E. S. P. Admiral
Knox, George Lt.-Col. late Colds. Gds.
Knox, G. W. Capt. Sco. Fus. Gds.
*Knox, Richard Col. 18th Hussars
Knox, T. E. CB. Col. 9th Regt.
Kyd, Hugh, M. Col. (ret.) Mad. Army (1*l.*)

LACON, W. Stirling, Esq. late H. C. S. (1*l.*)
Lacy, G. de Lacy Capt. 12th Regt. (1*l.*)
Lacy, T. E. Col. Major and Superintendent of Studies Roy. Mil. College (1*l.*)
Laing, Joseph Lieut. 14th Regt. (1*l.*)
Lake, H. Atwell, CB. Col. unatt. *ADC. to the Queen*
Lamb, Wm. Wentworth Capt. (ret.) 7th Dragoon Guards
Lambert, F. W. Major 56th H.M. Beng. N.I.
Lambert, *Sir* George Robert, KCB. Adm.
Lambert, John Arthur Col. Gren. Gds. (1*l.*)
Lambert, R. Capt. late 43rd Lt. Inf.
*Lambert, Rowley Capt. R.N. (1*l.*)
Lambton, Arthur Capt. Colds. Gds.
Lambton, Francis Lt.-Col. Sco. Fus. Gds. (1*l.*)
Lamert, Geo. F. Capt. Paym. late 30th Regt. (1*l.*)
Lamont, James Dep. Lieut. Bute
Lamotte, C. W. Lt.-Col. late unatt.
Lane, C. L. Lieut. 7th Royal Fus. (1*l.*)
Lane, Fred. Wm. Capt. late 67th Regt.
Lane, George Capt. Royal Elthorne Lt. Inf.
Lane, H. J. B. Capt. Colds. Gds. (1*l.*)
Lane, J. Theophilus Maj.-Gen. (ret.) Beng. Army
Langford, T. N. Capt. R.N. (1*l.*)
Langley, G. C. Col. Dep.-Adj.-Gen. R.M. L. I. (1*l.*)
Lascelles, C. F. R. Col. late Gren. Gds.
Lascelles, *Hon.* E. W. Maj. late 1st W. York Mil.
Lateward, John Capt. late 2nd Dr. Gds.
Latour, W. Young Capt. Gren. Gds. (1*l.*)
Laurie, J. D. Capt. 34th Regt.
Laurie, J. W. Lt.-Col. Par. Ser.
Laverton, F. K. Ens. 14th Regt. (1*l.*)
Lavies, J. Esq. Surgeon Invalid Artillery (1*l.*)
Law, E. D. Lieut. R.N. (1*l.*)
Law, *Hon.* H. S. Capt. late 28th Regt. (1*l.*)
Law, Robert K. H. Maj.-Gen. Col. 2nd W. I. Regt. (1*l.*)
Lawley, *Hon.* R. N. Lieut. York Hussars, Capt. late 2nd Life Guards
Lawrell, Digby H. Major late 64th Regt.
Lawrence, H. J. H. Asst. Sur. Gr. Gds.
Lawrenson, John M.-Gen. Insp.-Gen. of Cav.
Lawrie, H. R. F. Major late 79th Highs.
Laws, M. R. S. Ens. 62nd Regt. (1*l.*)
Layard, W. T. Col. Ceylon Rifles
Leach, Edm. Capt. 50th Regt. (1*l.*)
Leahey, Arthur Maj. Royal Engineers (1*l.*)
Leake, Robert Martin Lieut.-Gen. (1*l.*)
Leask, J. G. M.B. Asst. Surg. 94th Regt.
Leather, John Towlerton Capt. 2nd Dorset Artillery Volunteers (1*l.*)
Le Blanc, T. E. Capt. late 37th Regt.
Le Cocq, H. Capt. R.A. Bombay (1*l.*)
*Le Couteur, J. Col. Jersey Mil. *ADC. to the Queen* (1*l.*)
Le Couteur, J. H. Lt.-Col. Colds. Gds. (1*l.*)
Lee, J. E. Lieut. 55th Regt. (1*l.*)
Lee-Jortin, Henry W. Lt. late 2nd Life Gds. (1*l.*)
Lee-Mainwaring, C. W. Capt. Colds. Gds. (1*l.*)
Leeke, *Sir* H. J. *Bt.* K.C.B. K.H. Vice-Adm.
Leeson, Charles E. Lieut. 34th Regt. (1*l.*)
Leeson, R. J. P. Capt. 34th Regt. (1*l.*)
Lefroy, J. Henry, F.R.S. Brig.-Gen. R.A. Sec. Ord. Select Com. (1*l.*)
LeGeyt, W. F. Esq. Mil. Storekeeper.
Legge, *Hon.* Edw. H. Capt. Colds. Gds. (1*l.*)
Legge, *Hon.* C. G. Ens. Rifle Brigade (1*l.*)
Legge, *Hon.* Heneage Lieut. Colds. Gds. (1*l.*)
Legge, W. D. Lieut. 5th Fusiliers
Leggett, R. A. Capt. 69th Regt. (1*l.*)
Legh, George Cornwall Maj. 2nd Royal Cheshire Mil. M.P. (1*l.*)
Le Grice, Frederick Lieut. Roy. Art. (1*l.*)
Leigh, Lord Lord-Lieut. Warwick
Leigh, Wm. Capt. late Monmouthsh. Mil.
Le Mesurier, A. A. Capt. 14th Regt. (1*l.*)
Lemon, Thomas, C.B. Col. Roy. Marine Light Infantry (1*l.*)
Lempriere, A. R. Capt. R.E. (1*l.*)
Lempriere, George R. Capt. R.E. (1*l.*)
Lempriere, Henry Maj. (ret.) R.A. (1*l.*)
Lennard, T. G. B. Ens. 70th Regt. (1*l.*)
Lennock, G. G. Admiral
Lennox, Lord G. C. G. Lieut. late R. H. Gds.
*Lenon, John F. Lieut. R.N. (1*l.*)
Leonard, Peter, M.D. Dep. Insp.-Gen. of Hosp. and Fleets (1*l.*)
Le Patourel, Hy. Capt. South Glouc. Mil.
Le Quesne, J. C. Capt. 12th Roy. Lancers
*Leslie, Arthur Col. 40th Regt.
Leslie, John H. Lieut. 71st High. L.I. (1*l.*)
Leslie, Thomas Capt. R. H. Gds. (1*l.*)
Lethbridge, C. Col. (ret.) Madras Army
Levett, Theoph. J. Capt. late 1st Life Gds.
Levinge, *Sir* Richd. *Bart.*, M.P. Lt.-Col. late Westmeath Rifles (1*l.*)
Lew, Albert Paymaster R.N. (1*l.*)
Lewes, W. L. Capt. 48th Regt.
Lewis, Adolphus J. Lieut. Hon. Art. Comp.
Lewis, Charles Algernon Major-Gen. (1*l.*)
Lewis, G. O. Capt. 7th Roy. Fus. (1*l.*)
Lewis, Geo. W. Lieut. 23rd R. W. Fus.
Lewis, H. F. P. Lieut. R.A.
Lewis, John Edw. Lt.-Col. (ret.) 68th Rt.
Lewis, J. Owen Lt.-Col. late 37th Regt.
Lewis, Robert Lt. 71st Highland Lt. Inf.
Lewis, T. E. Lieut. H. M. Indian Navy (1*l.*)
Leyland, T. N. Capt. late 2nd Drags.
Leyland, T. Lieut. late 2nd Life Gds.
Liddell, *Sir* John, MD. CB. Dir.-Gen. Nav. Med. Dept. (1*l.*)
Liddell, W. H. Commr. R.N. (1*l.*)
Liddon, Matthew Lieut. 8th or King's
Ligertwood, T. (MB.) Surg. 4th Huss. (1*l.*)
Lightbody, John Surgeon h.p. Staff (1*l.*)

Lillie, *Sir* John Scott Lt.-Col. late Gr. Gds. (1*l.*)
Lindsay, *Sir* Alex. KCB. Gen. (ret.) Ben. Army (1*l.*)
Lindsay, *Hon.* C. H. Lt.-Col. late Gren. Gds. Major 11th Middx. Rifle Volrs (1*l.*)
Lindsay, G. H. Esq. late Capt.
*Lindsay, Henry Gore Capt. late Rifle Brig. Major Brecknock Rifle Volrs.
Lindsay, *Hon.* James Maj.-Gen. late Gren. Gds. MP. (2*l.*)
Lindsay, James, MD. Surgeon R.N.
Lindsay, Robert J. Lloyd, ✠.C. Lt.-Col. late Scots. Fus. Gds. Lt. Northampt. Mounted Rifle Volrs. (1*l.*)
Listowel, EARL of Capt. late S. F. Gds.
Litchfield, E. F. Lieut. H.M. 5th Beng. N.I. (1*l.*)
Littledale, Edward Major, late 1st Roy. Dr.
Lloyd, Francis T. Lieut. Roy. Art. (1*l.*)
*Lloyd, Thomas Lieut. 35th Roy. Sussex Regt.
Lloyd, William, MD. Staff Surg. H. M. Indian Army
Loch, Geo. Capt. late Duke of Lancaster's Yeo. Cav.
*Lock, A. C. Knox Major 50th Regt. (1*l.*)
Lock, H. Capt. 108th Mad. Inf. (1*l.*)
Lockhart, Arch. Inglis, CB. Col. 92nd Highs.
Lockhart, W. E. Capt. 26th Cameronians (1*l.*)
Locock, Herbert Lieut. Roy. Eng. (1*l.*)
Lodder, Henry Coll. Major 47th Regt. (1*l.*)
*Lodder, W. W. Lt.-Col. 59th Regt. (1*l.*)
Lodge, W. R. Capt. (ret.) Indian Army (1*l.*)
Logan, T. G. MD. Insp.-Gen. of Hospitals (1*l.*)
Logie, Cosmo Gordon, MD. Surg.-Major R. H. Gds. (1*l.*)
*Lombard, G. C. S. Capt. Adj. Civil Service Vols. (1*l.*)
Long, Chas. P. Capt. 13th Lt. Inf. (1*l.*)
Longden, Henry Errington, CB. Col. (ret.) 10th Regt. (1*l.*)
Longfield, F. Capt. 8th or King's (1*l.*)
Longford, The *Right Hon.* the EARL of, CB. Col. unatt.
Longmore, Thos. Dep. Insp. Gen. of Hospls. and Prof. Army Med. School Chatham (1*l.*)
Loraine, *Sir* Lambton, *Bart.* Lt. R.N. (1*l.*)
Loring, Wm. CB. Capt. R.N. *ADC. to the Queen* (1*l.*)
*Lovaine, LORD Lt.-Col. Northumb. Mil. MP.
Love, *Sir* Jas. Fred. KCB. KH. Gen. Col. 57th Regt. (1*l.*)
Lovell, E. L. Capt. (ret.) 8th Huss.
Lovell, John Williamson, CB. Lieut.-Col. R.E. (1*l.*)
Low, Alex. Col. (ret.) 4th Light Drags.
Low, *Sir* John, KCB. Lt.-Gen. H.M. Madr. Army.
Lowe, A. Rear-Admiral
*Lowe, E. W. D. CB. Col. 6th Regt. (1*l.*)
Lowe, R. H. C. D. Major Gren. Gds.
Lowe, W. D. Capt. unatt.
Lowry, E. L. B. Capt. 41st Regt. (1*l.*)
*Lowry, Rob. Wm. Col. 47th Regt.
Lowther, H. Capt. Westmoreland and Cumberland Yeomanry Cavalry (1*l.*)
Luard, John Lieut.-Col. late 30th Regt.
Luard, John Maj.-Gen. (ret.) Mad. Army (1*l.*)
Luard, R. G. A. Colonel unatt. (1*l.*)
Lucan, G. E. EARL of, KCB. Lieut.-Gen. Col. 8th Hussars
Lucas, W. Dep. I. Gen. Roy. Mil. Asylum, Chelsea (1*l.*)
Ludlow, John Maj.-Gen. (ret.) Ben. Army (1*l.*)
Lumley, Aug. Savile Capt. late 2nd Life Gds.
Lumsden, H. W. Capt. R. A. Madras
Lushington, *Sir* Stephen, KCB. Rear-Adm. (1*l.*)
Lynch, Staunton G. S. Cornet 14th Huss. (1*l.*)
Lynch, W. W. Major 2nd Queen's (1*l.*)
Lynn, James Lt.-Col. (ret.) R.E.
Lyon, *Hon.* Claude B. Lt. late 2nd Life Gds.
Lyon, Francis Capt. R.A. (1*l.*)
Lysons, D. CB. Col. Dep. Quar. Master Gen. Canada (1*l.*)

MABERLY, Wm. Leader Lieut.-Col. unatt.
M'Cann, N. MD. Surg. Roy. Middl. Mil.
*Macauley, G. W. Capt. Comt. Scinde Horse (1*l.*)
Macbean, Fred. KH. Lt.-Col. late 84th Regt.
McBean, Wm. Major 1st W. I. Regt. (1*l.*)
M'Cleverty, Wm. A. Maj.-Gen. Comm. Div. Madras (1*l.*)
M'Clure, *Sir* Rob. J. Le M. Kt. CB. Capt. R.N. (1*l.*)
M'Coy, T. R. Capt. late 65th Regt.
McCrea, J. D. Capt. R.N. (1*l.*)
M'Crea, Joseph Surg. R.N.
McDiarmid, H. C. Lieut. Roy. Eng. (1*l.*)
*McDonald, A. M. Lt.-Col. 7th Rifle Dep. Batt. Winchester (1*l.*)
McDonald, P. Capt. 48th Middl. Rif. Volrs. (1*l.*)
Macdonald, C. K. Major late 42nd Royal Highrs. (1*l.*)
Macdonald (of Clanranald), Reginald, J. J. G. Capt. R.N. (1*l.*)
Macdonell, A. S. late Inspec.-Gen. of Army Hospitals
MacDonnell, H. J. Lieut. 12th Regt. (1*l.*)
MacDougal, J. P. Capt. (ret.) Ben. Army
Macdougall, Patrick L. Col. unatt. (1*l.*)
MacGauran, F. Esq. Clerk War Office
McGoun, Thos. Lieut. (ret.) 43rd Light Inf.
MacGrath, E. J. Asst.-Surg. 8th Huss.
M'Gregor, *Sir* Duncan, KCB. Lieut.-Gen. (1*l.*)
M'Grigor, *Sir* Chas. *Bart.* Army Agent
Macgrigor, H. G. Lieut. 17th Regt.
McIllree, J. D. Dep. Insp.-Gen. of Hospitals

Macintosh, A. Fisher, KH. Lieut.-Gen. Col. 93rd Highs. (1*l.*)
Mackay, Henry Fowler Capt. unatt.
Mackenzie, J. D. Capt. 14th Regt. (1*l.*)
Mackenzie, Kennett D. CB. Col. late 92nd Highs. Dep. Adj.-Gen. Ireland
Mackenzie, *Sir* Wm. *Bart.* Dep. Lieut. Rosshire (1*l.*)
McKillop, H. F. Capt. R.N. (1*l.*)
Mackinlay, John Lieut. 94th Regt.
Mackinnon, L. B. Commr. R.N. (1*l.*)
Mackinnon, W. A. Surgeon 57th Regt. (1*l.*)
McLaughlin, Edwd. Capt. Royal Art. (1*l.*)
Maclean, Allan Cornet 1st Roy. Drs. (1*l.*)
Maclean, A. T. Lt.-Gen. Col. 13th Huss. (1*l.*)
*Maclean, F. D. Major 13th Huss.
Maclean, P. Col. Roy. Art.
Maclean, W. C. M.D. Dep. Insp. Gen. Prof. of Medicine, Fort Pitt (1*l.*)
Macleod, D. Maj.-Gen. Col. H. M. 4th Mad. Light Cav. (1*l.*)
MacLeod, Norman Lt. late Hon. Art. Comp.
M'Leroth, Thomas Lieut. h.p. R.M.L.I. (1*l.*)
Macliver, David Lieut. 2nd Som. Mil. (1*l.*)
M'Master, V. M. A. Surg. M.D. 18th Huss. (1*l.*)
M'Murdo, W. M. S. CB. Col. Insp. of Volunteers, *ADC. to the Queen* (1*l.*)
McNair, Fred. Roy. Art. Madras (1*l.*)
N'Namara, *Sir* Burton, *Kt.* Vice-Admiral
Macnamara, Fras. Lt.-Col. Clare Militia
Macnamara, F. R. Lieut. 93d Highs. (1*l.*)
Macpherson, Evan Major late 14th Light Dragoons (1*l.*)
Macpherson, G. G. Lieut. Colds. Gds. (1*l.*)
Macqueen, James D. Capt. unatt. (1*l.*)
Madden, W. W. Lieut. 8th or King's (1*l.*)
Madox, H. KH. Col. late 12th Royal Lancers
Magens, F. D. Capt. late 1st Life Gds.
Magill, J. McG. Capt. 2nd Queen's (1*l.*)
Magrath, J. R. Capt. R.A. (1*l.*)
Maguire, Rochfort Capt. R.N.
Mahon, Viscount Capt. Gren. Gds. (1*l.*)
Maitland, C. L. B. Col. (ret. h.p.) Gren. Gds.
*Malan, C. H. Capt. 75th Regt. (1*l.*)
Malcolm, G. A. CB. Major-General (1*l.*)
Malcolm, G. J. Commr. R.N. (1*l.*)
Malcolm R. Major R. E. Bombay (1*l.*)
Malcolm, W. Lieut. 10th Regt.
Malet, C. St. Lo. Lt.-Col. late S. Fus. Gds.
Malet, H. C. E. Lt.-Col. Gr. Gds.
Mallet, Hugh Capt. late 4th Lt. Drags. (1*l.*)
Malthus, Sydenham Capt. 94th Regt.
Malton, W. D. Capt. Scottish Borderers Mil. (1*l.*)
Man, H. Garnet Lt.-Col. late 54th Regt. Capt. Commt. London Eng. Volrs. (1*l.*)
Manby, Charles 7th Lan. Art. Vols. (1*l.*)
Mangles, James, FRS. Capt. R.N.
Mangles, W. H. Capt. late 50th Regt. R.E. Midd. Mil. (1*l.*)
Mann, J. B. Col. h.p. unatt. Town Major, Devonport (1*l.*)
Manners, A. C. Lieut. 57th Regt.
Manners, Lord Geo. John Lt.-Col. R.H. Gds.
Mansfield, *Sir* W. R. KCB. Lt.-Gen. Col. 38th Regt., Comm.-in-chief, Bombay
Manson, A. R. Col. Bom. Army (1*l.*)
March, Wm. H. Col. Commdt. R.M.L.I. (1*l.*)
Marchant, C. H. Ens. late 82nd Regt. (1*l.*)
Margesson, W. G. Capt. 56th Regt. (1*l.*)
Margitson, John Capt. late 48th Regt. (1*l.* 1*s.*)
Marindin, H. R. Maj. late 1st Royals (1*l.*)
Markham, E. Capt. late H.E.I.C. Sea. Ser. (1*l.*)
Markham, W. T. Capt. late Colds. Gds.
Marrillier, C. H. Lieut. Cape M. Rifles (1*l.*)
*Marriott, H. Christopher Maj. 60th Roy. Rifles (1*l.*)
Marryat, J. H. Capt. R.N.
Marsh, *Sir* Henry D. *Bart.* Major late 3rd Drag. Gds.
Marsh, J. Paym. R.N. (1*l.*)
Marsh, Robert Maj. late 24th Regt.
Marsh, W. D. Capt. Roy. Eng. (1*l.*)
Marshall, F. G. Lieut. 86th Regt. (1*l.*)
Marten, Thomas, KH. Lieut.-Gen. Col. 6th Inniskillen Drags.
Martin, Edw. Lieut. late 28th Mad. N. I. (1*l.*)
Martin, *Sir* Henry B. KCB. Vice-Adml. (1*l.*)
*Martin, Thomas Major 4th King's Own (1*l.*)
Martin, *Sir* Wm. F. KCB. Admiral (1*l.*)
Martyn, Cecil E. Lieut. 6th Drag. Gds. (1*l.*)
Martyn, F. M. Col. (ret.) 2nd Life Gds.
Martyn, Peter Capt. late 88th Regt.
Marvin, Wm. Major late Royal Art. (1*l.*)
Massey, *Hon.* Lionel E. Capt. S. F. Gds.
Massey, *Hon.* N.H.C. Col. late 4th W.Y. Mil.
Matheson, Thomas Maj.-Gen. (1*l.*)
Mathew, B. H. Capt. R. E. Bombay (1*l.*)
Mathew, J. J. Capt. 5th Fus. (1*l.*)
Mathew, W. H. Capt. 45th Regt.
Matson, E. Major-General R.E.
Matthews, F. P. Capt. 1st Sussex Rifle Volrs. (1*l.*)
Matthews, Henry G. Ens. late 44th Regt.
Maude, *Hon.* Francis Capt. R.N. (1*l.*)
Maude, G. A. CB. Lieut.-Col. (ret.) R.H.A.
Maunsell, E. E. Commr. R.N. (1*l.*)
Maunsell, F. Lieut.-Gen. Col. 53rd Regt.
Maunsell, F. R. Major R. E. Bengal (1*l.*)
Maxse, Fred. A. Capt. R.N.
Maxse, H. F. B. Lt.-Col. late Colds. Gds.
Maxwell, Jas. Lt.-Col. 34th Regt. (1*l.*)
Maxwell, J. Balfour Rear-Admiral (1*l.*)
Maxwell, *Sir* W. A. *Bart.* Col. late 1st Drags.
May, Allan Lieut. Roy. Eng. (1*l.*)
Maycock, Dottin Capt. Edm. R. R. Regt.
Maycock, J. G. Capt. 14th Regt. (1*l.*)
Mayne, J. O. Capt. Roy. Eng. Madras (1*l.*)
*Mayne, Rich. C. Commr. R.N. (1*l.*)
Mayo, John H. Lieut. West Norfolk Mil. (1*l.*)
Mayo, W. R. Esq. Dep. Asst. Sup. of Stores (1*l.*)
Mayow, George Wynell Col. unatt. (1*l.*)
Meade, R. R. Capt. 8th or King's (1*l.*)
*Meaden, Jas. Capt. Ceylon Rifles (1*l.*)

Mee, Charles H. Major-Gen. (ret.) R.A.
Meehan, Geo. Walker Lt.-Col. unatt.
*Mein, A. Major 4th Lanark. Rif. Volrs. (1*l.*)
Mellor, A. Ens. 8th or King's
Melville, *Hon.* N. L. Capt. 25th K. O. Borderers
Mends, Geo. C. Capt. R.N.
Mends, Herbert Col. (ret.) 2nd West I. R.
Mends, W. R. CB. Capt. R.N. Director of Transports (1*l.*)
Mercer, Alex. Cavalie Lieut.-Gen. Col. Comm. R.A.
Methuen, F. H. P. LORD Lt.-Col. R. Wilts. Mil. *ADC. to the Queen*
Meyrick, Aug. W. H. Lt.-Col. Sco. Fus. Gds.
Michell, *Sir* John, KCB. Gen. Col. Comm. R.A.
Michell, *Sir* John, KCB. Maj.-Gen. Col. 86th Regt. (1*l.*)
Michell, J. Edward Lieut.-Col. R.H.A. (1*l.*)
Middleton, *Sir* George N. Broke, *Bart.* CB. Rear-Admiral (1*l.*)
Middleton, John Major late Rifle Brigade (1*l.* 1*s.*)
Middleton, O. R. Lieut. 4th King's Own (1*l.*)
Middleton, W. H. H. C. Gent.-at-Arms
Midford, R. Esq. Ordn. Dep. (1*l.* 1*s.*)
*Mildmay, *Sir* Henry, *Bart.* Lt.-Col. Hants. Yeo. Cav. (1*l.*)
Mildmay, H. A. St. J. Lt. Rifle Brigade (1*l.*)
Miles, H. R. W. Ens. 5th Fus. (1*l.*)
Mill, James Lt.-Col. late 78th Highs. (1*l.*)
Millar, J. A. Lieut. Royal Eng. (1*l.*)
Miller, D. Capt. R.N. (1*l.*)
Miller, Frederic, V.C. Major R.A., Topo. Depart. War Office (1*l.*)
Miller, James Lt.-Col. late 11th Hussars
Miller, Robert B. Commander R.N.
Miller, T. C. Ens. 43rd Regt. (1*l.*)
Miller, William V. Paymt. R.N. (1*l.*)
Miller, W. H. CB. Maj.-Gen. (ret.) Mad. Army (1*l.*)
Milles, *Hon.* G. W. Capt. (ret.) R. H. Gds.
Mills, C. J. C. Col. (ret.) 94th Regt.
Mills, Wm. Master R.N. (1*l.*)
Mills, Wm. Ens. 14th Regt. (1*l.*)
Milman, G. A. Lieut.-Col. Roy. Art. (1*l.*)
Milne, *Sir* Alex. K.C.B. Rear-Admiral (1*l.*)
Minchin, F. C. Lt.-Col. late Beng. N. I. (1*l.*)
Minet, C. W. Esq. late W. Kent Yeomanry
Minty, R. G. P. Ens. 12th Hants. Rifle Volrs.
Mitchell, T. J. Capt. (ret.) 1st Dr. Gds. (1*l.*)
Moffat, Bowland Col. h.p. unatt. (1*l.*)
Moffatt, K. M. Lt.-Col. Royal Can. Rif. (1*l.*)
Molesworth, A. O. Lieut. Roy. Art. (1*l.*)
*Molesworth, M. C. Capt. R.E. (1*l.*)
Molesworth, R. Capt. (ret.) 1st Roy. Drag. (1*l.*)
Molony, C. M. Capt. R.A. (1*l.*)
Molony, W. M. Maj. late 22nd Regt. (1*l.*)
Moncrieff, G. D. W. Capt. R.E. (1*l.*)
*Moncrieff, Geo. H. Lt.-Col. Scots. F. Gds. (1*l.*)
Monro, James, M.D. Surg.-Maj. late Colds. *Gds.*
Monson, Hon. D. J. Capt. (ret.) 96th Regt.
Montgomerie, Patrick, C.B. Lieut.-Gen. R.A. Madras
Montresor, Henry Edw. Lieut.-Col. (ret.) Gr. Gds.
Moore, A. G. Montgomery Capt. 4th Huss.
Moore, Fras. Ens. 8th or King's
Moore, G. Lt.-Gen. H. M. Bom. Army (1*l.*)
Moore, H. Lt.-Col. C.B. (ret.) Beng. Army
Moore, John, C.B. Capt. R.N. (1*l.* 1*s.*)
Moore, John C. Capt. Rifle Brigade (1*l.*)
Moore, J. L. Capt. 34th Regt.
Moore, R. C., C.B. Col. Roy. Art. Madr. (1*l.*)
Moore, Thomas, C. C. Maj.-Gen. R.M.L.I.
Moorsom, Robert Lieut.-Col. late Sco. Fus. Gds. Lt.-Col. Sussex Rifle Volunteers.
Morant, Horatio Harbord Lt.-Col. 68th Lt. Inf. (1*l.*)
Morant, W. Sam. Capt. late Gren. Gds. (1*l.*)
Moreland, Jos. Capt. late Hon. Art. Comp.
Moreton, *Hon.* Algernon T. Capt. late 3rd Huss.
*Morgan, Horatio Capt. and Paymr. 43rd Light Infantry
Morris, Edm. F., C.B. Lieut.-General, Col. 49th Regt.
Morris, Hen. Joseph Maj.-Gen. (ret. f.p.) R.A.
Morrison, W. L. Capt. R.E. (1*l.*)
Morse, H. B. Dep. Com. General (1*l.*)
Morton, C. Brooke Lieut.-Col. (ret.) Bombay Army
Morton, G. de C. Ens. 6th Regt. (1*l.*)
Moseley, W. H. Lieut. 60th Roy. Rifles
Mostyn, *Hon.* M. H. Lieut. 1st Roy. Dr. (1*l.*)
Mostyn, *Hon.* Roger Lt.-Col. Sco. Fus. Gds.
Mottram, H. G. Lieut. 4th Worcestershire Rifle Volrs. (1*l.*)
Mounsey, C. J. Capt. 71st High. Lt. Inf.
Mount-Charles, G. H. EARL of Lieut.-Col. 1st Life Gds.
Mountain, R. F. Lt.-Col. Roy. Art. (1*l.*)
Muncaster, LORD Capt. late Rifle Brig. (1*l.*)
Mundy, A. M. Capt. late Notts. Mil.
Mundy, *Sir* George Rodney, K.C.B. Vice-Admiral
Munro, Campbell Capt. late Gren. Gds.
Murchison, Rod. M. Capt. late 50th Regt.
Murc, Wm. Lt.-Col. (ret.) Sco. F. Gds. (1*l.*)
Murphy, J. W. C.N. Asst. Surg. 75th Regt. (1*l.*)
Murray, Aug. Geo. E. Lieut. R.N.
Murray, G. F. Lieut.-Col. 65th Regt. (1*l.*)
Murray, John Lt.-Col. late Gr. Gds. (1*l.*)
Murray, John Commr. R.N. (1*l.*)
Murray, LORD J. C. P. Col. (ret.) Sco. Fus. Gds. (1*l.*)
Murtogh, John Surg. h.p. 6th Regt.
Mussenden, W. Capt. 8th Hussars
Myers, W. J. Col. h.p. R.S.C.
Mylius, F. J. Capt. 5th Fus. (1*l.*)

NANGLE, Henry Capt. 15th Regt. (1*l.*)
Nangle, W. C. Capt. Roy. Art. (1*l.*)
Napier, Geo. T. C., C.B. Major-Gen. Com. Division Canada
Napier, Gerard John Capt. R.N. (1*l.*)

Napier, R. H. Lieut. R.N. (1*l.*)
Nares, G. S. Commr. R.N. (1*l.*)
*Nason, Jno. Lt.-Col. 12th Dep. Batt. Athlone (1*l.*)
Naylor, Jas. Sadler Lt.-Col. late 8th Huss.
Nedham, W. R. Col. R.A.
Nelson, Horatio Comm. R.N. (1*l.*)
Nelson, Thos. M.D. Surg. R.N.
Nepean, Evan, Esq. War Office (1*l.*)
Neville, Edward Lt.-Col. Sco. Fus. Gds.
Newdigate, Edw. Lieut.-Col. 2nd Dep. Batt. Chatham
Newdigate, F. W. Lt.-Col. late Golds. Gds. Lt.-Col. Staffd. Rifle Volunteers (1*l.*)
Newton, C. E. Maj. Derbyshire Rifle Volrs. (1*l.*)
Newton, Sam. Chas. Lieut. R. H. Gds. (1*l.*)
Newton, W. E. Lt. 1st Midd. Art. Volrs. (1*l.*)
Newton, Wm. Sam. Col. h.p. Colds. Gds.
Nicholls, Henry Maj. (ret.) 94th Regt. (1*l.*)
Nicholson, Lothian, C.B. Lt.-Col. R.E. (1*l.*)
Nicholson, S. J. Capt. R.A. (1*l.*)
Nicol, James Capt. late 13th L. I. (1*l.*)
Nicoll, Chas. R. Surg.-Maj. Gren. Gds. (1*l.*)
Nicolls, Geo. Green Lt.-Col. late 1st Dr. Gds.
Nicolson, *Sir* Fred. W. E. *Bart.* C.B., Rear-Admiral (1*l.*)
Nind, P. Capt. 1st Midd. Art. Volrs. (1*l.*)
Noble, Andrew Capt. late R.A.
Noble, Jno. Geo. Capt. 1st Roy. Lan. Mil. (1*l.*)
Noble, W. Capt. late Q.O.L.I. Mil. (1*l.*)
*Noddall, C. T. Commr. R.N. (1*l.*)
Nolloth, Edward, M.D. Staff Surg. R.N.
Norbury, T. C. N. Capt. late Dr. Gds.
Norcott, Wm. S. R. C.B. Col. unatt. (1*l.*)
Norman, Henry Lieut. late 10th Hussars
Norman, H. W. C.B. Col. 31st Beng. L.I. Mil. Sec. Beng. *ADC. to the Queen* (1*l.*)
*Norris, Geo. Goodwin Capt. 2nd Warwick Mil. (1*l.*)
North, C. F. Maj.-Gen. (ret. f.p.) R.E. (1*l.*)
*North, C. Napier Lt.-Col. 60th Rifles (1*l.*)
North, J. S. D. Col. late Q.O.L.I. Mil. MP. (1*l.*)
North, R. M. Maj. (ret.) H. M. Indian Army (1*l.*)
North, *Hon.* W. H. J. Lieut. late 1st Life Gds.
Northey, E. R. Capt. late 52nd L.I. (1*l.*)
Norton, F. C. Ens. late Hon. Art. Comp. (1*l.*)
Norton, John Capt. late 34th Regt. (1*l.*)
Nott, A. H. Capt. H.M. Indian Navy
Nugent, C. B. P. N. H. Major R.E. (1*l.*)
Nugent, C. Edward Lieut. late 43rd L.I.
Nugent, E. C. Capt. (ret.) Gren. Gds.
Nugent, *Sir* G. E. *Bart.* Lt.-Col. late Gr. Gds. (1*l.*)
Nugent, St. G. M. Major unatt. (1*l.*)
Nuthall, W. F. Lt.-Col. 3rd Beng. N.I. (1*l.*)

OAKLEY, Geo. J. A. Capt. 68th L.I. (1*l.*)
O'Brien, Donatus Capt. late R.S.C.
O'Brien, H. H. Donatus Major (ret.) R.A.
O'Brien, Joseph Vice-Adm.
*O'Brien, J. T. N. Major 20th Regt.
O'Brien, R. S. Maj. Staff Officer of Pen. (1*l.*)
O'Brien, Terence Major-Gen. Comg. Troops in Ceylon
O'Byrne, Robert, Esq. FRGS. Navy Agent (1*l.*)
O'Connor, L. S. CB. Col. I.F.O.
O'Flaherty, Rich. James Dep. Insp. Gen. of Hospitals (1*l.*)
Ogilvie, Alex. MD. h.p. Dep.-Insp.-Gen. Ordn. Med. Dep.
Ogilvy, Thomas Col. late 2nd Life Gds. (1*l.*)
O'Halloran, H. D. Col. (ret. f.p.), 1st W. I. Regt. (1*l.*)
Oldfield, Aldred Capt. 15th Regt. (1*l.*)
Oldfield, Chas. J. Lt.-Col. (ret.) Ben. Army
*Oldfield, Richd. Capt. Royal Artillery (1*l.*)
Oldfield, R. B. Capt. R.N. (1*l.*)
Oldfield, T. W. Col. (ret.) Beng. Army (1*l.*)
Oliveira, B. FRS. FSA. Capt. late Surrey Yeomanry Cavalry
Ommanney, Octavius Capt. Surrey Rifle Volunteers (1*l.*)
Onslow, Arthur Edw. Lieut.-Col. late Sco. Fus. Gds.
Ord, Harry St.-G. Col. R.E. Lt.-Gov. Dominica
Ord, W. Redman Lieut.-Gen. Col. Commt. R.E.
Orkney, T. J. Earl of Capt. Commt. Bucks Yeo. (late 9th Lanc.)
Orlebar, Orlando Comm. R.N.
Ormsby, Arthur Capt. unatt.
Ormsby, John William Col. R.A.
Ormsby, Thomas Capt. late 92nd Highs.
Osborn, H. J. R. Lieut. 1st Life Gds. (1*l.*)
Osborne, J. J. Ens. 15th Regt.
Ostrehan, E. S. Lieut. H.M. 25th Bomb. N.I.
Otway, Charles Maj.-Gen. R.A.
Ouchterlony, T. H. Lieut. R.A.
*Owen, G. A. Lieut. 107th Beng. Inf. (1*l.*)
Owen, C. H. Major R.A. Prof. of Art. Roy. Mil. Academy, Woolwich (1*l.*)
Owen, H. C. Cunliffe, CB. Col. R.E.

PAGET, C. H. M. Ens. 29th Regt. (1*l.*)
Paget, Fred. Col. late Colds. Gds. (1*l.*)
Paget, G. E. Lieut. R. H. Gds. (1*l.*)
Paget, Joseph Capt. Derby Mil. (1*l.*)
Paget, Patrick L. C. Lt.-Col. late Sco. Fus. Gds.
Pakington, *Right Hon. Sir* John, S. *Bart.* GCB. MP.
Paley, R. S. Capt. 12th Roy. Lancers
Palliser, E. M. Capt. 7th Huss.
Palliser, Wm. Major unatt. Maj. Brig. Dublin (1*l.*)
Palmer, Frederick Capt. Sco. Fus. Gds.
Palmer, John Capt. R.N. (1*l.*)
Palmer, Roger Lieut.-Col. 2nd Life Guards
Palmes, John P. Comm. R.N. (1*l.*)
Panter, H. G. Major 22nd Regt. (1*l.*)
*Parish, H. Woodbine Maj. 45th Regt. (1*l.*)
Parke, Wm. CB. Col. h.p. 53rd Regt. (1*l.* 1*s.*)
Parker, A. E. Ens. 91st Highlrs.
*Parker, *Sir* Chas. C. *Bart.* Admiral
Parker, C. W. Capt. 4th Royal Middl. Mil. late 69th Regt.

Parker, John Rear-Admiral
Parker, Richard Major-Gen. (1*l.*)
Parker, *Sir* William, *Bart.*, GCB. Admiral of the Fleet
• Parkinson, J. Lieut. (ret.) 57th Regt. (1*l.*)
Parlby, Geo. Lt.-Col. late 4th Regt. (1*l.*)
Parlby, Wm. Maj.-Gen. (1*l.*)
Parminter, *Rev.* H. BA. Chap. R.N. (1*l.*)
Parnell, A. Lieut. R.E. (1*l.*)
Parnell, *Hon.* Hy. W. Lieut. late R.N. (1*l.*)
Parnell, W. H. Capt. Gren. Gds.
Parratt, J. E. T. MD. h.p. Insp. Gen. of Hospls.
Parry, F. W. B. Lieut. 22nd Regt. (1*l.*)
Parsons, L. H. H. Lieut. R.H.A. (1*l.*)
Parsons, Wm. Lieut. R.N. (1*l.*)
Pasley, Charles Major R.E. (1*l.*)
Pasley, *Sir* Thos. Sabine, *Bart.* Vice-Adm. (1*l.*)
Patience, Jas. Col. (ret.) 65th Regt.
Patten, John Wilson Col. 3rd Roy. Lanc. Mil. *ADC. to the Queen*, M.P.
Patten, Eustace J. Wilson Capt. 1st Life Gds.
Patterson, David Aikman Capt. Pay. 27th Regt.
*Patterson, W. T. L. Lieut.-Col. 91st Highrs. (1*l.*)
Patton, H. C. Capt. 22nd Regt.
Patton, John Major-Gen. (1*l.*)
Paty, *Sir* Geo. Wm. KCB. KH. Gen. Col. 70th Regt.
Paulet, Lord Frederick, C.B. Major-Gen. Commanding Division of Guards (1*l.*)
Paxton, A. F. Lieut. h.p. 11th Drs. (1*l.*)
Payn, Wm. Col. C.B. 72nd Highs. (1*l.*)
Payne, W. R. Commr. R.N.
Paynter, John Capt. (ret.) Sco. Fus. Gds.
Peacock, Geo. late Master R.N. (1*l.*)
Peacocke, T. G. Capt. late 94th Regt.
Pearse, Joseph Rear-Adm.
Pearson, C. K. Capt. 3rd Buffs (1*l.*)
Pearson, F. B. Capt. late 1st R. Chesh. Mil. (1*l.*)
Pearson, R. L. O. Bt.-Major Gren. Gds.
Pearson, William Lieut. 45th Regt. (1*l.*)
Peddie, Geo. Capt. 41st Regt. (1*l.*)
Peel, A. Lennox Major 52nd Lt. Inf.
Peel, Cecil Lennox Capt. Sco. Fus. Gds. (1*l.*)
Peel, Jonathan, *Right Hon.* Lieut.-General
Peel, J. Floyd Capt. late Sco. Fus. Gds.
Pellew, P. W. Commr. R.N. (1*l.*)
Pemberton, C. P. Capt. Sco. Fus. Gds.
Pennant, A. H. Douglas Capt. Gren. Gds.
Pennant, *Hon.* E. G. D. Col. Commt. R. Carnarv. Rifle Corps, MP.
Pennefather, *Sir* J. Lysaght, KCB. Lt.-Gen. Col. 22nd Rgt. Comdg. Troops, Aldershot
Pennefather, R. D. Major E. Kent Mil.
Pennefather, R. P. Lieut. R.E. Madras
Pennethorne, L. P. Lieut. R.A. (1*l.*)
Pennington, *Hon.* A. J. Lieut. late Rifle Brig. (1*l.*)
Pennington, Edward, Esq. War Office (1*l.*)
Pennington, R. Capt. late Cumb. Mil.
Pepper, Geo. N. Capt. 31st Regt. (1*l.*)
Pepys, Edm. Lieut. late 1st Drags.
Perceval, H. L. Lieut. R.N. (1*l.*)
Perceval, Spencer Major-Gen.
Percival, Ernest A. Capt. late 11th Huss. (1*l.*)
Percival, Jno. J. Lt. (ret.) 17th Regt. (1*l.*)
Percy, *Hon.* Hugh Manvers C.C. Col. (ret. h.p.) Gren. Gds. *ADC. to the Queen*
Perigal, Fred. Esq. Admiralty (1*l.*)
Perrot, *Sir* E. G. Lambert, *Bart.* Capt. late E. Kent Mil. (1*l.*)
Pester, Henry Major-Gen. R.A.
Petley, Rob. Major h.p. 24th Lt. Drags. Prof. of Mil. Surveying at the Roy. Mil. Coll. Sandhurst (1*l.*)
Petre, John Barney Capt. late 1st. Drg. (1*l.*)
Petrie, Martin Capt. 14th Regt. (1*l.*)
Petrie, Samuel, CB. late Direc. of the Commissariat. (1*l.*)
Peyton, A. W. Capt. 1st Life Gds.
Peyton, Francis Col. 98th Regt. (1*l.*)
Phibbs, Owen Lieut. 6th Drag. Gds. (1*l.*)
Phibbs, Richd. Major 4th Roy. Lanc. Mil. (1*l.*)
Philips, Geo. Capt. R.E.
Philips, George Capt. 2nd Queen's (1*l.*)
Philips, N. G. Capt. late 47th Regt. Hon. Corps Gent.-at-Arms (1*l.*)
Phillimore, Wm. Brough Capt. late Gren. Gds.
Phillipps, Henry Lt.-Col. late 3rd Lt. Dgs. (1*l.*)
Phillips, Courtenay Maj. late 15th Huss.
Phillips, Paul Winsloe Major R.A.
Phillips, R. N. Col. h. p. unatt.
Phillips, *Sir* B. T. Major.-Gen. (1*l.*)
Phillips, L. Guy Capt. Gren. Gds. (1*l.*)
Philpot, Philip Capt. 11th Regt. (1*l.*)
Philpot, John T. Esq. Paymaster Gen. Office
Phipps, *Hon.* Sir C. Beaumont, KCB. Col. unatt. (1*l.*)
Phipps, C. E. Lieut. Sco. Fus. Gds. (1*l.*)
Phipps, R. W. Capt. R.A. (1*l.*)
Pickwick, Chas. H. S. Capt. late 2nd Som. Mil. Capt. Wilts. Rifle Volrs.
Pickwoad, E. Lt.-Col. St. Kit's Mil. (1*l.*)
Pidcock, Thomas Paymaster, R.N.
Piers, C. B. Capt. and Paymaster R.A.
Pigott, Francis P. Capt. late 16th Lancers
Pilgrim, J. Bunce Capt. unatt.
Pilkington, J. B. Lieut. 94th Regt.
Pilleau, H. G. Lieut. R.E. (1*l.*)
Pinder, George Col. Ret. f.p. (1*l.*)
Pipon, J. K. Col. h.p. 68th Regt. Asst. Adj. Gen. to the Forces
Pitt, W. L. Ens. 55th Regt. (1*l.*)
*Pittman, Frank Asst. Paym. H.M. Ship Naiad (1*l.*)
*Plasket, W. A. H. Lieut. 24th Regt. (1*l.*)
Platen, Count late R.N. (1*l.*)
Plowden, C. H. C. Esq. Board of Control (1*l.*)
Plummer, H. Capt. 7th Roy. Fus. (1*l.*)
Pocklington, E. H. F. Lt.-Col. unatt. Ass. Quartermaster-Gen.
Pocklington, F. Capt. 5th Fus.
*Pocklington, G. H. Capt. 18th R. Irish
*Pole, C. V. N. Major Cape M. Rifles (1*l.*)
Pole, Edward Major-Gen.

Pole, E. A. Lieut. 12th Lancers
Pollard, A. A. Lieut. 21st R.N.B. Fus.
Pollard, Chas. Capt. R.E. Bengal (1*l.*)
Pollard, H. W. Lieut. 67th Regt.
Ponsonby, A. E. V. Lt.-Col. 12th Regt. (1*l.*)
Ponsonby, *Hon.* Ashley J. G. Capt. late Gr. Gds.
Pooley, Henry Capt. 2nd Cheshire Art. Volrs. (1*l.*)
Pope, James S. Esq. late War Office
Pope, Joseph Sheppard Paymaster R.N.
Popham, Brunswick Rear-Admiral
Porrett, Robert, Esq. Ord. Dep. (1*l.*)
Portal, Robert Lt.-Col. late 5th R.I. Lancers
Porter, Hy. Edw. Maj.-Gen.
Porter, John Lt.-Col. ret. 67th Regt.
Porter, Thomas Capt. R.N. (1*l.*)
Porter, J. Whitworth Major Roy. Engineers Prof. of Fortn. R. M. Coll. Sandhurst (1*l.*)
*Portman, *Hon.* W. H. B. Col. West Som. Yeo. Cav. MP. (1*l.*)
Pote, C. St. Clair Ens. Cape Mtd. Rifles (1*l.*)
Potts, Geo. Brinewood Capt. Hon. Art. Coy. (1*l.*)
Powell, H. F. Capt. late Ceylon Rifle Regt.
Powell, R. A. CB. Capt. R.N.
Powell, Thomas Harcourt Capt. late Sco. Fus. Gds.
Power, W. J. Cornet 6th Inniskilling Drags. (1*l.*)
Power, W. T. J. Com. General-in-Chief CB. (1*l.*)
Powerscourt, W. W. Viscount Lieut. late 1st Life Gds. (1*l.*)
Pownall, Walter Major 48th Regt.
Powys, Charles Edw. Lieut. R.N. (1*l.*)
Powys, *Hon.* Charles J. Fox Lt. 36th Regt.
Powys-Keck, C. H. G. Ens. 60th Roy. Rifles (1*l.*)
Pratt, Lord G. M. Lieut. Gren. Gds. (1*l.*)
Pratt, Robert, CB. Col. 23rd R. W. Fus. (1*l.*)
Pratt, R. T. Capt. 69th Regt. (1*l.*)
Pratt, *Sir* Thomas Simpson, KCB. Maj.-Gen. Col. 37th Regt. Com. Troops Melbourne
Prendergast, G. A. Capt. late 5th Beng. Eur. Cav. (1*l.*)
Prentis, W. T. Capt. late 2nd R.N.B. Drags. (*l*)
Prescott, A. S. K. Asst. Surg. R.A. (1*l.*)
Preston, D'Arcy S. Commr. R.N. (1*l.*)
Preston, H. E. W. Lieut. 50th Regt. (1*l.*)
Preston, J. N. Capt. late 3rd Lt. Drags.
Price, Edward, CB. Col. R.A. (1*l.*)
Price, G. E. Lieut. R.N. (1*l.*)
Price, T. C. Lieut. R.A. (1*l.*)
Prichard, A. Capt. H.M. 28th Madras N.I. (1*l.*)
Pringle, J. H. Lt.-Col. Commt. 6 Lanc. Mil. late Sco. Fus. Gds.
Prior, A. de M. Lieut. R.A. (1*l.*)
Prior, H. M. Esq. late Ordn. Dep. (1*l.*)
Prowse, J. F. Lieut. R.N. (1*l.*)
Puckle, J. Capt. H.M. 3rd Mad. Lt. Inf.
Pullen, W. J. S. Capt. R.N. (1*l.*)
Pulleyne, Edm. Lieut. 18th Huss. (1*l.*)
Purssord, J. Esq. Ensign late 103rd Regt.

QUIN, Michael Vice-Adm. (1*l.*)
Quin, Richard R. Capt. R.N.

RADCLIFFE, William Capt. R.N.
Raikes, P. B. Lieut. R.A.
Raines, Julius A. R. CB. Col. 95th Regt.
Raines, J. R. Lieut.-Col. late 48th Regt.
*Rainier, Daniel Col. 98th Regt.
Rains, S. W. Dep. Purveyor to the Forces
Raitt, Charles Rt. Col. late unatt.
Raitt, E. A. Esq. Ord. Dept. (1*l.*)
Ralston, W. C. Lieut. 21st R.N.B. Fus.
Ram, Stephen J. Capt. Sco. Fus. Gds. (1*l.*)
Ramsay, B. D. W. Major unatt. Dep. Asst. Quar.-Mast. Gen. (1*l.*)
Ramsay, Francis Capt. (ret.) R.A.
Ramsey, T. W. late Commissary-Gen.
Randall, Alfred Ens. Ceylon Rifles
Randolph, C. G. Vice-Adm. (1*l.*)
Randolph, Charles Wilson Lieut.-Col. Gren. Gds. (1*l.*)
*Randolph, G. G. Capt. R.N. (1*l.* 10*s.*)
Raper, Charles Lieut. late Bucks Yeo.
*Ratcliffe, C. Capt. 1st Warwick Rifle Volrs. (1*l.*)
Rawdon, John Dawson Lieut.-Gen.
Rawlison, George Maj. late 1st W.I.R. (1*l.*)
Read, Constantine Lt.-Col. h.p. Roy. Staff Corps (1*l.*)
Read, C. C. Asst. Surg. Gren. Gds.
Read, C. H. Capt. Edm. Roy. Rifles (1*l.*)
Read, John M. Ens. 13th L. Inf. (1*l.*)
Ready, Charles Lt.-Col. (ret.) 55th Regt. (1*l.*)
Reddie, Jas. Esq. Admiralty Som. House (1*l.*)
Redmond, J. P. Lt.-Col. 61st Regt.
Reed, Thomas, CB. Lieut.-Gen. Col. 44th Regt. (1*l.*)
Reeve, Ellis, PF. Capt. Cold. Gds.
Reeve, Fred. Capt. 73rd Regt. (1*l.*)
Reeve, John Lt.-Col. late Gr. Gds.
Reeve, Wm. H. Lt.-Col. Colds. Gds.
Reid, A. G. Capt. (ret.) Beng. Army (1*l.*)
Reid, D. Capt. and Adj. 4th Dep. Batt.
Reid, George Capt. Beng. Cav. (1*l.*)
Reilly, W. E. M. CB. Major Roy. Art. (1*l.*)
Rennie, J. CB. Capt. H.M. Ind. Navy (1*l.*)
Renny, Henry Col. 81st Regt. (1*l.*)
Renny, Henry Laws Lieut. (ret.) R.E.
Reynolds, John W. Col. Dep. Adj.-Gen. Jamaica (1*l.*)
Ricardo, A. L. Capt. Gren. Gds.
Rice, C. Major 72nd Highs.
Rich, Charles Rear-Admiral
Richards, P. Lieut. 94th Regt.
Richardson, James Col. unatt. (1*l.*)
Richardson, J. Lieut. 4th Glamorgan Rifle Volrs. (1*l.*)
Richardson, John Geo. Major (ret.) R.M.L.I.
Ricketts, St. Vincent W. Col. unatt.
Riddell, Reginald Charles Lieut. Hants. Mil.
Ridge, Robert Stuart Major (ret.) 36th Regt.
Ridgway, Alex. Capt. 1st Devon Mil.
Ridgway, A. F. Esq. Army Agent (1*l.*)

Ridley, Chas. Wm. C.B. Major-Gen. Commanding Division, Dublin (1*l.*)
Ridley, Wm. John Maj.-Gen. Commanding Division Malta (1*l.*)
Ripley, Thos. G. F. Esq. Ord. Dep. (1*l.*)
Robarts, H. C. Esq. Dep. Lieut.
Roberts, C. P. Capt. Roy. Horse Art. (1*l.*)
Robertson, Fred. Lieut. 10th Regt. (1*l.*)
Robertson, Jas. Elphinstone Col. 21st R.N.B. Fus.
Robertson, Roderick Capt. late 70th Beng. N.I.
Robertson, W. Capt. 1st. R.E. Mid. Mil.
Robeson, George Lt.-Col. late Mil. Train (1*l.*)
Robinson, *Sir* G. A. *Bart.* Maj. late 22nd Regt. (1*l.*)
Robinson, G. C. Capt. 11th Hussars
Robinson, Henry Lieut. R.E. (1*l.*)
Robinson, *Sir* Hercules Gov. of Hong Kong (1*l.*)
Robinson, H. W. Asst. Surg. Beng. Army
Robinson, J. G. Lt.-Col. late Sco. Fus. Gds.
Robinson, Oliver Col. (ret.) F.P. (1*l.*)
Robinson, W. T. Major H.A.C. (1*l.*)
Rochfort, J. D. Capt. Roy. Lanc. Rifles (1*l.*)
Rodd, John R. Capt. R.N. (1*l.*)
Rodger, Wm. Capt. R.N. (1*l.*)
Rofe, Samuel Paym. h.p. 14th Lt. Drags.
Rokeby, H. Lord, K.C.B. Lieut.-Gen. Col. 77th Regt. (1*l.*)
Rolleston, Jas. Commr. R.N.
Rollo, *Hon.* R. Col. Mil. Sec. Canada (1*l.*)
Romer, Rt. Frank Maj.-Gen. (ret.) R.A.
Rooke, C. A. Lieut. late Hon. Art. Comp. (1*l.*)
Rooke, Willoughby S. Capt. Sco. Fus. Gds.
Rooper, Bonfoy Lieut. late 34th Regt.
Rose, G. E. Maj. Rifle Brigade
Ross, Albert E. Maj. 5th Fus. Dep. Asst. Quar.-Mas. Gen. Aldershot (1*l.*)
Ross, *Sir* Hew Dalrymple, G.C.B. Gen. Col. Commt. R.A. (1*l.*)
Ross, John, C.B. Lt.-Col. Rifle Brig. (1*l.*)
Ross, W. H. Lieut. 23rd Bombay N.I.
Rosse, W. Earl of Col. King's Co. Mil. (1*l.*)
Rough, W. Henry Capt. Hon. Art. Comp. (1*l.*)
Roupell, C. M. Capt. Inns of Court Volrs. (1*l.*)
Rous, George Grey Lt.-Col. late Gren. Gds.
*Rouse, Rolla Capt. 3rd Suffolk Rifle Volrs. (1*l.*)
Rowcroft, F. C.B. Major-Gen. H.M. Beng. Army (1*l.*)
Rowcroft. H. C. Lieut. R.E. Bengal
Rowles, James Capt. late Rifle Brig.
Rowley, J. A. Capt. 13th Lt. Inf. (1*l.*)
Rowsell, E. P. Ens. Lon. Rifle Volrs. (1*l.*)
Rudd, Henry Maj. (ret.) Bomb. Army (1*l.*)
Ruddiman, Thos. Capt. (ret.) Mad. Army (1*l.*)
Rudduck, J. B. Esq. late Professor of Mathematics Mil. Sem. Addiscombe
Rumley, Randal Major-General unatt. Insp. Gen. of Inf.
Ruse, Richard Capt. late 9th Regt.
Rushout, C. F. R. Lieut. Roy. H. Gds.
Russell, *Sir* Charles, *Bart.* M.C. Lieut.-Col. Gren. Gds.
Russell, Lord Chas. Jas. Fox Lt.-Col. late 60th Royal Rifles.
Russell, D. C.B. Major-Gen. (1*l.*)
Russell, Lord Edward, C.B. Vice-Adm.
Russell, F. H. Lieut. late Sco. Fus. Guards
Russell, Henshaw Lt.-Col. late 60th Rifles Staff Officer of Pensioners, Plym. (1*l.*)
Russell, J. C. Cornet 10th Huss. (1*l.*)
Russell, Lindsay Capt. R.E. Bengal (1*l.*)
Rutherford, J. H. Major (ret.) R.E. Gov. of Mil. Prison, Dublin.
Rycroft, C. A. W. Cornet Hants. Yeo. Cav. (1*l.*)
Rycroft, Nelson Capt. late 1st Stafford Mil.
Ryder, Alfred P. Capt. R.N. (1*l.*)

SABINE, Edw. D.C.L. F.R.S. Maj.-Gen. R.A. (1*l.*)
St. Aubyn, Lionel Lieut. Mil. Train (1*l.*)
St. Clair, *Hon.* C. W. Maj. 57th Regt. (1*l.*)
St. Clair, S. G. B. Capt. (ret.) 21st R. N. B. Fus. (1*l.*)
St. George, James Major Dep. Sup. of Stores
St. George, J. CB. Col. Roy. Art. Pres. Ord. Sel. Committee (1*l.*)
St. Paul, D. R. Lieut. late 45th Regt.
Salmond, Wm. Lieut. R.E. (1*l.*)
Salt, Thos. Capt. 2nd Stafford Mil.
Saltoun, Alex. Lord Lt.-Col. late Commt. Aberdeen Mil. (1*l.*)
*Salusbury, Fred. Lieut.-Col. 101st Royal Beng. Fus. (1*l.*)
Salwey, Alfred Dep. Com. General
Sanders, Gilbert H. Capt. Barrack Mas. Parkhurst (1*l.*)
Sanders, G. O. Capt. late Leicester Mil.
Sandham, Henry Major-Gen. R.E. Lieut.-Gov. Comt. Roy. Mil. Acad. (1*l.*)
Sandys, Edwin W. Lieut. R.A. (1*l.*)
Sartorius, *Sir* George Rose, *Kt.* Admiral (1*l.*)
Saumarez, *Hon.* James St. V. Lieut. Gr. Gds. (1*l.*)
Saunders, H. F. Lt.-Col. Hon. Corps Gent.-at-Arms (1*l.*)
Saurin, E. Admiral (1*l.*)
Savage, F. S. Major 86th Regt. (1*l.*)
Savage, Henry John Lieut.-Gen. Col. Comdt. R.E.
*Sawyer, C. Col. 6th Drag. Gds. (1*l.*)
Sawyer, G. W. Ens. 8th or King's
Saxe Weimar, *H. S. Highness* Prince Wm. Augustus Edward of, C.B. Col. Gren. Gds. *A.D.C. to the Queen* (1*l.*)
Sayer, Fred. Capt. h.p. 23rd R. W. Fus.
Scarlett, *Hon. Sir* J. Y. KCB. Major-Gen. Col. 5th Dr. Gds. Adj.-Gen. to the Forces
Schaw, H. Capt. Roy. Eng. (1*l.*)
*Schreiber, F. W. Lt.-Col. Suff. R. Volrs. (1*l.*)
Scott, A. de C. Capt. Roy. Eng. (1*l.*)
Scott, *Hon.* Chas. Grantham Col. late Sco. Fus. Gds. Lt.-Col. Wor. Rifle Volunteers
Scott, C. H. S. Capt. Beng. Staff Corps
Scott, Edward Major late 8th Huss. Lt.-Col. Kent Rifle Volunteers

Scott, E. W. S. Major-Gen. Roy. Art. (1*l.*)
Scott, Hen. Alex. Lieut.-Gen. Col. Commdt. R.A.
Scott, Hen. Young D. Capt. R.E.
Scott, *Sir* James, KCB. Vice-Adm. (1*l.*)
Scott, H. B. Major 9th Regt.
Scott, J. D. Col. late Madras Art. (1*l.*)
Scott, R. A. E. Commr. R.N. (1*l.*)
Scott, *Sir* Sibbald David, *Bart.* Capt. late Roy. Sussex Militia Artillery (1*l.*)
Scott, T. A. Lieut. H.M. 28th Beng. N.I.
Scott, Wm. Hen. Gen. Col. 36th Rt. (1*l.*)
Scovell, E. W. Col. late 96th Regt.
Scovell, G. T. Capt. 79th Highlanders (1*l.*)
Scovell, Thornton Lieut. 63rd Regt.
Scriven, John Lt.-Col. Commt. R. S. Mid. Mil.
Scrymgour, Wm. Capt. R.N. (1*l.*)
Seafield, J. C. EARL of late R.N.
*Seaman, W. C. MD. Surg. Maj. 72nd Highrs.
Sefton, W. P. EARL of Capt. late Grenadier Gds. (2*l.*)
Selwyn, J. H. Capt. R.N. (1*l.*)
Seton, W. C. Lieut. 82nd Regt. (1*l.*)
Settle, H. T. Capt. and Adj. R. Sussex Mil. Art. (1*l.*)
Sewell, T. D. Capt. Lond. Rifle Brigade Volrs. (1*l.*)
Seymour, Francis, CB. Maj.-Gen. late Sco. Fus. Gds.
Seymour, F. Beauchamp P. CB. Capt. R.N.
Seymour, F. H. A. Capt. Rifle Brigade
Seymour, F. Hugh G. Major-Gen.
Seymour, G. A. Capt. R.N. (1*l.*)
Seymour, Leopold R. Lieut. Gren. Gds. (1*l.*)
*Seymour, W. F. Capt. Colds. Gds. (1*l.*)
Shadforth, Henry General (1*l.*)
*Shanks, J. G. 1st Lieut. Roy. Mar. Lt. Inf. (1*l.*)
Sharp, J. H. Lt. 17th Surrey Rifle Volrs. (1*l.*).
Sharpe, Benjamin Commr. R.N. (1*l.*)
Sharpe, M. S. Capt. Mil. Train (1*l.*)
Shawe, C. Aug. Gen. Col. 74th Highs.
Shawe, J. W. Lieut. ret. 97th Regt. (1*l.*)
Sheffield, Robt. Maj. late R. H. Gds.
Sheil, *Sir* Justin, KCB. KLS. Major-Gen. H.M. Ben. Army (1*l.*)
Shelley, Charles Capt. Sco. Fus. Gds.
Shells, F. C. Capt. late 11th Hussars (1*l.*)
Shepheard, Wm. Rear-Adm. (1*l.*)
Sherbrooke, Wm. Lieut. R.N. (1*l.*)
Sherson, Alex. Nowell Capt. unatt. (1*l.*)
Shipley, W. D. Capt. 58th Regt. Mil. Sec. Cape of Good Hope (1*l.*)
Shirley, H. CB. Major-Gen. (1*l.*)
Shirreff, R. D. F. Capt. 8th or King's
Shore, *Hon.* H. J. Capt. ret. Sco. Fus. Gds. (1*l.*)
Showers, Chas. Lionel Maj. late 14th Beng. N.I.
Shrewsbury and Talbot, EARL of, CB. Vice-Adm.
Shuckburgh, *Sir* Francis R. *Bart.* F.R.S. Dep. Lieut. of Warwick
Shuckburgh, G. T. Franc. Maj. late Sco. F. Gds.
Siborne, H. T. Capt. R.E. (1*l.*)
Sibthorp, C. C. W. Capt. late 1st Drags.
Sidebottom, Vernar L. Major unatt. (1*l.*)
Sidley, H. Edm. de Burgh, Col. (ret.) 50th Regt. (1*l.*)
Silk, Geo. C. Lieut. S. Middl. Rifle Volrs. (1*l.*)
Sim, E. C. Capt. R.E. (1*l.*)
Simpson, G. W. Y. Col. R.A. Madras (1*l.*)
Simpson, R. Hamilton Cap. & Paym. 65th Regt.
Sinclair, W. Thomson, Esq. h.p. Dep. Com. Gen.
Singer, Morgan Capt. R.N. (1*l.*)
Singleton, John Maj.-Gen. (ret. full pay) 11th Regt.
Sitwell, H. C. Lieut. late H.M. 5th Beng. L. Cav.
Sitwell, H. S. Lieut. R.E.
Skill, H. H. Lieut. 11th Regt. (1*l.*)
Skinner, T. H. Lieut. (ret.) 8th or King's
Skinner, Thos. Major late Ceylon Rifles
Skipton, S. S. MD. Assist. Surg. 78th High. (1*l.*)
*Skipwith, George Major 14th Depôt Batt. Belfast (1*l.*)
Skyring, Chas. Francis Col. R.E.
Slacke, W. R. Lieut. R.E.
Slade, *Sir* Alex. F. A., *Bart.* Capt. 100th Regt. (1*l.*)
Slade, Charles G. Capt. Rifle Brig. (1*l.*)
Slade, William H. Major-Gen. R.E.
Sladen, Joseph Lieut. Roy. Art. (1*l.*)
Sleigh, *Sir* J. W. KCB. Gen. Col. 9th Lancers (1*l.*)
Slessor, E. A. Lieut. Roy. Art. (1*l.*)
Sloper, N. W. Capt. R. Wilts. Mil.
Smart, Robt. KH. Vice-Admiral (1*l.*)
Smith, A. MD. late Director-General Army Med. Dep.
Smith, Astley C. Major 25th K. O. Borderers (1*l.*)
Smith, C. B. L. Capt. Mad. Staff Corps (1*l.*)
Smith, F. Harrison Commr. R.N. (1*l.*)
Smith, Felix V. Capt. late 2nd Dr. Gds.
Smith, Gerrard Capt. Sco. Fus. Gds.
Smith, H. C. Lieut. R.E. Madras (1*l.*)
Smith, H. Fowl. M.D. Staff-Surgeon (1*l.*)
Smith, Hy. Porter Lieut. h.p. Rifle Brig. (1*l.*)
Smith, James Webber, C.B. Col. unatt. *ADC. to the Queen*
Smith, Jervoise Capt. Roy. Edmonton Rifles
Smith, Jno. H. Lieut. Roy. Engrs. (1*l.*)
Smith, J. H. Capt. R.E. (1*l.*)
Smith, John Louis Maj.-Gen. (ret.) R.A.
Smith, *Sir* J. M. Frederic, KH. Gen. Col. Commandant R.E.
Smith, Joshua Simmonds Maj.-Gen. (1*l.*)
*Smith, J. W. Ens. 1st Royals (1*l.*)
*Smith, Percy G. L. Capt. R.E. (1*l.*)
Smith, P. H. Ens. 11th Regt. (1*l.*)
Smith, Rob. M. Lieut R.E. (1*l.*)
*Smith, Seymour Spencer Lieut. R.N. (1*l.*)
Smith, Thomas, Esq. Army Agent
Smith, Thos. Charlton Maj.-Gen. (1*l.*)
Smith, Wm. Lea Lieut. 13th Light Inf. (1*l.*)
Smith, W. Lieut. h.p. R. Art. Drivers

Smith, W. Sydney Vice-Adm.
Smyth, Henry, CB. Col. (ret.) 76th Regt. (1*l.*)
Smyth, Henry Augustus Maj. R.A. (1*l.*)
Smyth, J. G. Col. 2nd West York Lt. Inf. M.P.
Smyth, J. H. CB. Col. R.A. Bengal (1*l.*)
Smyth, J. M. Capt. (ret.) 10th Regt. (1*l.*)
Smyth, James S. Lieut. 63rd Regt.
Smythe, Wm. Jas. Col. R.A.
Soady, F. J. Maj. Roy. Art. (1*l.*)
Sole, H. W. Major 5th West York Militia (1*l.*)
Somerset, Edw. Arth. Col. h.p. unatt. Asst. Qua. Mas.-Gen. Portsmouth
Sondes, G. W. Lord Capt. late R. H. Gds.
Sotheby, Edward S. C.B. Capt. R.N. *ADC to the Queen.*
Sotheby, F. E. Capt. Rifle Brig. (1*l.*)
Sotheby, F. S. CB. Lt.-Col. (ret.) Bengal Art. (1*l.*)
Sparks, R. H. Capt. 7th Roy. Fus. (1*l.*)
Spearman, H. R. Lieut. 91st Highrs.
Spedding, Carlisle Lt.-Col. h.p. 32nd Regt. (1*l.*)
Speirs, Arch Alex. Capt. Sco. Fus. Gds.
Spence, Jno. Ens. 67th Regt. (1*l.*)
Spencer, *Hon.* J. W. S. Capt. R.N.
Spencer, *Hon.* R. C. H. Col. (ret.) R.A.
*Spenlove, J. F. S. Capt. Fife Art. (1*l.*)
Spicer, Henry Capt. late 4th Royal Middl. Mil. (1*l.*)
Spicer, R. W. Capt. late 16th Lancers
Spink, John, KH. Lieut.-Gen. Col. 2nd Queen's Royals (1*l.*)
Spragge, F. P. Lieut. R.E. Bengal (1*l.*)
Stace, W.S. Capt. R.E.
Stacey, J. W. Esq. Clerk Contract Branch (1*l.*)
Stack, Nath. M. Maj.-Gen.
Stanhope, *Sir* Edwin F. S. *Bart.* Capt. R.N. (1*l.*)
Stanhope, H. Admiral
Stanhope, Philip Spencer Lieut.-Gen. Col. 13th Light Inf. (1*l.*)
*Stanhope, Walter T. S. Capt. 1st West York Yeo. Cav. (1*l.*)
Stanley, C. E. H. Capt. Gren. Gds. (1*l.*)
Stanley, Fras. S. Cornet R. H. Gds. (1*l.*)
*Stanley, *Hon.* Fred. A. Capt. Gr. Gds. (1*l.*)
Stanley, *Hon.* J. C. Lt.-Col. Gr. Gds. (1*l.*)
Stanton, Wm. Commr. R.N. (1*l.*)
Stapleton, F. G. Capt. 33rd Regt.
Stapylton, G. G. C. Lt.-Col. 32nd Light Inf. (1*l.*)
Staunton, Geo. Maj.-Gen.
Staveley, Edmund Lieut. R.A. (1*l.*)
*Stawell, W. St. L. Alcock Lt.-Col. North Cork Rifles (1*l.*)
*Steele, Aug. F. Lt.-Col. 7th Huss. (1*l.*)
Steele, T. Montague, CB. Col. (ret.) Colds. Gds. *ADC. to the Queen*
Stehelin, Ben. Spicer Major.-Gen. R.E. (1*l.*)
Stephens, F. S. M. Capt. 2nd Royal Middl. Rifle Militia
Stephenson, B. C. Lieut. 2nd R. Middl. Mil.
Stephenson, F. C. A. CB. Col. S. F. Gds. (1*l.*)
Stephenson, S. V. Capt. Sco. Fus. Gds.
Stepney, A. St. G. H. CB. Col. Colds. Gds. (1*l.*)
Stepney, S. Cowell, KH. Lieut.-Col. late Colds. Gds. (1*l.*)
Steuart, Ramsay Lieut. 94th Regt.
Stevens, J. Harvey Maj.-Gen. R.M.L.I. (1*l.*)
Stevens, Wm. Capt. 67th Regt. (1*l.*)
Stevenson, Hen. Lieut. 6th Inns. Drags.
Stevenson, J. Lieut. 12th Roy. Lans.
Stevenson, Thos. Paym. late 7th Dr. Gds.
Stevenson, W. G. Lieut. late Sco. Fus. Gds.
Stewart, Colvin Capt. Scottish Borderers Mil. (1*l.*)
Stewart, D. S. Capt. late 11th Hussars
Stewart, R. C. Capt. late 8th Mad. Light Cav. (1*l.*)
Stewart, R. C. Maj. 2nd Queen's (1*l.*)
Stewart, R. F. S. Lieut. late Sco. Fus. Gds.
Stewart, *Sir* Houston, KCB. Adm. (1*l.*)
Stewart, W. Houston, CB. Capt. R.N. (1*l.*)
Stirling, Francis Lieut. R.N. (1*l.*)
Stirling, J. S. Capt. Roy. Art. (1*l.*)
Stirling, W. Major Roy. Art. (1*l.*)
Stokes, Alfred Lieut. 88th Regt. (1*l.*)
Stoney, F. S. Lieut. Roy. Art.
Stopford, James J. Rear-Adm. (1*l.*)
Stopford, Richard H. Rear-Admiral
Storer, Arthur T. Capt. R.E. (1*l.*)
Storks, *Sir* Henry K. KCB. Maj.-Gen.
Stourton, Marmaduke Lieut. 8th or King's
Stovin, *Sir* Frederick, GCB. KCMG. Gen. Col. 83rd Regt. (1*l.*)
Stracey, Edw. J. Lt.-Col. late Sco. Fus. Gds. (1*l.*)
Stracey, Henry H. D. Capt. Sco. Fus. Gds.
Strachan, J. Lieut. (ret.) 94th Regt.
Strahan, William Lieut. R.A.
Strange, A. FRAS. Lt.-Col. late H.M. 7th Mad. Cav. (1*l.*)
Strange, H. F. CB. Col. Roy. Art. (1*l.*)
Strangways, W. A. F. Capt. R.H. Art.
Stratford, Robert Ens. 51st K.O.L. Inf.
Streathfield, Chas. Ogle Maj.-Gen. R.E. (1*l.*)
Strickland, Edw. Dep. Com. Gen. (1*l.*)
Strong, Clem. W. Lt.-Col. Colds. Gds. (1*l.*)
Stuart, Charles Maj.-Gen. h.p. Ceyl. Rifles (1*l.*)
Stuart, H. B. Lieut. Roy. Beng. Army (1*l.*)
Stuart, J. F. D. Crichton Lt.-Col. (ret.) Gr. Gds. MP. (1*l.*)
Stuart, Wm. Jas. Major Roy. Eng. (1*l.*)
*Stuart, Wm. Tyler Capt. 17th Regt. (1*l.*)
Studd, Edward Major-General
Sturdy, James Barlow Stewardson Capt. 5th Lancashire Artillery Volunteers
Sturgeon, Chas. Ens. late 24th Regt.
Sturt, C. N. Lt.-Col. Gr. Gds. MP. (1*l.*)
*Styan, Arthur Capt. Queen's Westminster Rifle Volunteers (1*l.*)
Sulivan, G. A. F. Col. (ret.) 5th Lt. Drs.
Sullivan, Wm. CB. Maj.-Gen.
Sutherland, Edward Maj. unatt. Barrack Mas. Woolwich
Sutton, John Major late 47th Regt.
Swan, J. Percival Capt. 3rd Roy. Middl. Mil.

Swann, Jno. S. Capt. 22nd Regt. (1*l.*)
Sweney, Mark H. Capt. R.N. Greenwich Hosp.
Sweny, John C. Capt. (ret.) 91st Highrs.
Swinburne, C. H. Vice-Admiral (1*l.*)
Swindley, J. E. Major unatt. (1*l.*)
Swiney, G. Clayton Lieut. 6th Drag. Gds.
Swiney, Geo. Gen. R.A. Beng. (1*l.*)
*Swinfen, F. H. Major 5th Dr. Gds.
Sykes, F. H. Capt. late 11th Huss.
Sykes, W. H. FRS. Col. (ret.) Bom. Army MP. (1*l.*)
Symonds, T. E. Commr. R.N. (1*l.*)
Symons, C. E. H. Lieut. Roy. Art.

TABUTEAU, A. O. Capt. 93rd Highrs.
Talbot, C. R. M. Esq. Dep. Lieut.
*Talbot, *Hon.* W. L. Maj. h.p. 21st R.N.B. Fus. (1*l.*)
Talbot, Harvey W. Maj. 1st Middl. Eng. Volrs. (1*l.*)
Tannar, T. Capt. 4th King's Own
Tanner, Edward Capt. 8th or King's
Tarbet, P. G. Lieut. R.E. (1*l.*)
Tate, Jas. Roddam Paym. R.N. (1*l.*)
Tatham, Edward Capt. R.N.
Tattnall, R. C. Commr. R.N. (1*l.*)
Taylor, Arthur Joseph Col. R.A.
Taylor, Brook Maj.-Gen. Comg. 1st Inf. Brigd. Aldershot
Taylor, *The Rev.* H. A. MA. late Chaplain to the Forces
Taylor, *Sir* H. G. A. KCB. Gen. H.M. Mad. Army (1*l.*)
Taylor, J. M'K. Lt.-Col. H.M. 2nd Bomb. Lt. Cav.
Taylor, R. C. H. CB. Col. Asst. Adj. Gen. Dover.
Taylor, Thos. Matt. Lieut.-Gen. H.M. Bengal Army (1*l.*)
Teasdale, Washington Lieut. 1st W. York Art. Volrs.
Teesdale, Henry George Col. R.H.A.
Teevan, Alfred Lieut. 55th Regt. (1*l.*)
Teevan, Geo. J. Capt. 94th Regt.
Teevan, Henry Ensign 75th Regt. (1*l.*)
Tempest, A. C. Capt. 11th Hussars
Tempest, Thos. R. P. Col. (ret.) 23rd Royal Welsh Fusiliers
Templetown, Viscr. Maj.-Gen. Asst. Col. Commt. 60th Royal Rifles (1*l.*)
*Teush-Hecker, C. H. Col. Asst. Commt. Cav. Depôt Maidstone (1*l.*)
Thelluson, A. G. B. Major late Colds. Gds.
*Thesiger, *Hon.* C. W. Major 6th Inns. Drs. (1*l.*)
*Thesiger, *Hon.* Fred. A. Col. 95th Regt. (1*l.*)
Thomas, C. D. Lieut. Colds. Gds. (1*l.*)
Thomas, H. J. Lt.-Col. (ret.) Roy. Art. (1*l.*)
Thomas, Jocelyn H. W. Capt. (ret.) Sco. Fus. Gds. (1*l.*)
Thomas, J. W. CB. Col. 67th Regt. (1*l.*)
Thomas, Montagu Commr. R.N. (1*l.*)
Thompson, T. H. Capt. 78th Highs. (1*l.*)
Thompson, Daniel Capt. 67th Regt.
*Thompson, P. S. Lieut.-Col. 14th Huss. (1*l.*)
Thompson, R. T. Lieut. 56th Regt. (1*l.*)
Thomson, Harry Gen. H.M. Beng. Army
Thomson, R. Kennedy Lieut. R.N.
Thorndike, Daniel Major-General R.A.
Thornton, Wm. Col. (ret.) Gren. Gds.
*Thorold, George E. Col. (ret. f.p.) Lt.-Col. Kent Rifle Volrs. (1*l.*)
Thring, J. E. Major R.A. (1*l.*)
Thrupp, M. F. Lieut. 4th King's Own
Thursby, Jas. L. Maj. h.p. 22nd Regt. (1*l.*)
Thursby, Rich. H. Capt. Colds. Gds.
Thynne, Alfred W. Capt. Gr. Gds. (1*l.*)
Tidy, T. H. Col. unatt. Asst. Adj. Gen.
Tinkler, W. A. Capt. late Hon. Corps Gen.-at-Arms
Tipping, Alfred Lieut.-Col. late Gren. Gds.
Tireman, Hy. Stephen Major (ret.) R.A.
Tollemache, Wm. Aug. Capt. late 2nd Life Guards
Tollnor, W. M. Lieut. R.A. (1*l.*)
Tolson, Wm. Lieut. 35th Roy. Sussex Regt. (1*l.*)
Tomkinson, E. Lt.-Col. late 8th Huss. Cav. Dep. Canterbury
Tomline, G. Col. N. Linc. Mil.
Tomline, Wm. Capt. late 10th Huss. (1*l.*)
Tompson, W. D. Capt. 17th Regt. (1*l.*)
Torrens, R. H. Cornet late 2nd Dr. Gds. (1*l.*)
Torriano, C. E. Capt. Roy. Art. (1*l.*)
*Tottenham, Charles James Capt. late 2nd Life Gds. Lt.-Col. Denbigh Yeo. Cav. (1*l.*)
Tottenham, C. G. Lt.-Col. Sco. Fus. Gds.
Toulmin, Augs. Esq. late H.E.I.C. Sea. Ser. (1*l.* 1*s.*)
Tower, H. Lt.-Col. Colds. Gds.
Townsend, H. J. Stephens T. Lieut. late 2nd Life Guards
Townsend, J. C. C. Capt. North Cork Rifles (1*l.*)
Townshend, Henry Dive Lieut.-Gen. Col. 25th Regt. (1*l.*)
Tracey, Harry A. Lieut. Roy. Art. (1*l.*)
Traill, Wm. Asst.-Surg. 91st Highrs.
Travers, E. A. B. Maj. Mad. Staff Corps (1*l.*)
*Travers, F. S. Capt. 60th Royal Rifles (1*l.*)
Travers, H. F. Esq. D. A. Storekeeper
Travers, J. O. Col. Asst. Adj. Gen. R.M.L.I.
*Trefusis, *Hon.* W. R. Capt. Sco. Fus. Gds. (1*l.*)
Tremayne, Arthur Lt.-Col. late 13th Lt. Drs.
Trench, C. Lieut. R.A. (1*l.*)
Trench, *Hon.* W. Le Poer Capt. R.E. (1*l.*)
*Trevelyan, H. A. Lt.-Col. 7th Hussars
Trevelyan, Jas. Harrington Lt.-Col. unatt.
Trevor, E. A. Lieut. R.E. Bengal
Trevor, G. H. Lieut. R.A. Madras
*Trevor, W. C. Lieut.-Col. 14th Regt. (1*l.*)
Tritton, F. B. Major 5th Dep. Batt. Isle of Wight
Trivett, J. F. Lieut. R.N. Reserve (1*l.*)
Trollope, Chas. CB. Maj.-Gen.
Trotter, H. Lieut. Gren. Gds. (1*l.*)
Troubridge, *Sir* T. St. V. H. *Bart.* C.B. Col. h.p. 22nd Regt. Dep. Adj. Gen. *ADC. to the Queen* (1*l.*)

Trousdell, W. G. MD. Surg.-Maj. 11th Regt. (1*l.*)
Trower, C. T. Col. (ret.) 103rd Roy. Bom. Fus.
Tryon, J. Lieut. 39th Regt.
Tryon, R. Capt. Rifle Brig.
Tudor, John Capt. R.N. (1*l.*)
Tuite, Hugh Manley Maj.-Gen.
Tulloh, Alex., C.B. Col. R.A. (1*l.*)
Tupper, Chas. Wm. Capt. late K.O.L.I. Mil.
Tupper, De Vic Capt. 8th or King's (1*l.*)
*Tupper, M. C. Selwyn Capt. 29th Regt. (1*l.*)
Turnbull, Edw. Dep. A. Com. Gen. (1*l.*)
Turnbull, G. A. Surg. Staff (1*l.*)
Turner, C. H. Capt. late Gren. Gds.
Turner, Geo. Esq. Master Shipwr. Woolwich (1*l.*)
Turner, Geo. H. Lieut. 50th Regt. (1*l.*)
Turner, Henry Assist.-Surg. Sco. Fus. Gds.
Turner, H. S. Capt. 69th Regt. (1*l.*)
Turner, James Trench Lieut. 73rd Regt. (1*l.*)
Tuyll, *Sir* Wm. KCH. Gen. Col. 7th Huss.
Tweedie, Michael Capt. h.p. R.A.
Twemlow, Geo. Maj.-Gen. R.A. Bengal (1*l.*)
Twyford, A. F. Lieut. 75th Regt. (1*l.*)
Twyford, H. Capt. 36th Regt. (1*l.*)
Twynam, P. A. A. Capt. 15th Regt. Dep.-Asst. Quartermaster-General, Aldershot (1*l.*)
Tylden, John Major-Gen. (ret.) R.A. (1*l.*)
Tylee, Alfred Col. (ret.) R.A. (1*l.*)
Tyler, C. J. Capt. R.A. (1*l.*)
Tyler, E. S. Capt. Royal Engs. (1*l.*)
Tyrone, J. H. de la Poer, EARL of Lieut. 1st Life Gds. (1*l.*)
Tyssen, F. S. D. Lieut. late 4th Drag. Gds.

UFFINGTON, W. A. F. VISCOUNT Major Berks Yeo. (ret.) Gr. Gds.
Underwood, G. A. Lt.-Col. (ret.) Mad. Art.
Upton, *Hon.* Arthur Major-General (1*l.*)
Urquhart, J. H. Lieut. Roy. Engs. (1*l.*)

VACHER, F. S. Bt.-Major 22nd Regt. Dep. Asst. Qr.-Master General (1*l.*)
Valpy, Ant. B. Capt. R.N. (1*l.*)
Vander-Meulen, J. H. Lieut. 50th Regt. (1*l.*)
Van-Straubenzie, F. Major 13th Lt. Inf. (1*l.*)
Varlo, George Maj. h.p. R. M. L. I. (1*l.*)
Vassall, Rawdon J. P. Col. unatt. (1*l.*)
Vaughan, J. F. Lt.-Col. R. Mon. L. I. Mil.
Ventry, T. T. A. LORD Capt. h.p. 43rd L. I.
*Vereker, *Hon.* S. P. Major-Commandant Limerick Artillery Militia
Verney, G. Hope Ens. Rifle Brigade (1*l.*)
Verney, *Sir* Harry, *Bart.* Major late Gren. Gds. MP. (1*l.*)
Vernon, G. A. Lieut.-Col. late Colds. Gds. Lieut.-Col. Staffordshire Rifle Volrs.
Verschoyle, H. W. Lt.-Col. Gren. Gds. (1*l.*)
Vertue, James Capt. R.E. Madras (1*l.*)
Vesey, Geo. Hy. Lieut.-Col. R.A.
Vesey, *Hon.* J. R. W. Lieut. Colds. Gds. (1*l.*)
Vicars, H. J. A. Major 18th Roy. Irish (1*l.*)
Villiers, Ernest Lieut. 43rd Light Inf.
Villiers, *Hon.* Fred. W. C. Capt. late Colds. Guards (1*l.*)
Vincent, J. L. Ens. 5th Fusiliers
Voyle, G. E. Lt.-Col. R.A. (1*l.*)
Vyner, R. C. de Grey Capt. Gr. Gds. (1*l.*)
Vyse, G. Howard Col. (ret.) 2nd Life Gds.
Vyvyan, W. C. Ens. late 4th K. O. (1*l.*)

*WADE, Hamlet Coote, CB. Col. late 13th L. I. (1*l.*)
Wade, John Peter Major (ret.) Beng. Army (1*l.*)
Wade, Seaton Surg. R.N. (1*l.*)
Wadman, A. J. P. Capt. King's Drag. Guards (1*l.*)
Wahab, G. D. Lieut. 20th Regt. (1*l.*)
Wahab, H. J. Capt. and Paym. 94th Regt.
Wake, R. W. Lt.-Col. h.p. Roy. Afr. Corps
Wale, Henry J. Lieut. late 2nd Drags.
Walhouse, Edward Capt. late 12th Regt.
*Walker, A. Lieut. 79th Highrs. (1*l.*)
Walker, D. Corrie Capt. Roy. Engs. (1*l.*)
Walker, Edw. Lieut. 21st R.N.B. Fus. (1*l.*)
Walker, F. W. E. F. Lieut. Sco. Fus. Gds. (1*l.*)
*Walker, G. G. Major Scottish Borderers Mil. (1*l.*)
Walker, *Sir* Geo. R. *Bart.* Capt. h.p. unatt.
Walker, Hercules Major Rifle Brigade
Walker, John Capt. late 66th Regt. (1*l.*)
Walker, John, Esq. Geographer East India Office
*Walker, S. Lieut.-Col. Q. O. L. Inf. Mil.
Walker, Wm. Capt. late 69th Regt. Prof. of Mil. Administration, Staff College, Sandhurst (1*l.*)
Wallace, *Sir* Jas. Maxwell, KH. Gen. Col. 17th Lancers (1*l.*)
Wallace, *Sir* W. T. F. *Bart.* Lt.-Col. (ret.) Gren. Gds.
*Waller, Geo. H. Major 7th Roy. Fus. (1*l.*)
Wallington, J. C. Major late 10th Hussars (1*l.*)
*Walmisley, J. R. L. Major-Commandant 1st Lon. Volr. Art. late Hon. Art. Comp. (1*l.*)
Walpole, Horatio Capt. 5th Northum. Fus.
Walpole, Wm. Admiral
Walsh, Arthur Capt. late 1st Life Gds.
Walton, Wm. Lovelace General Col. 5th Northumberland Fus. (1*l.*)
Walwyn, Jas. H. Capt. 23rd R. W. Fus.
Ward, Edw. Wolstenholme Lieut.-Col. R.E.
Ward, H. Capt. (ret.) Bengal Army
Ward, John Commr. R.N. (1*l.*)
Ward, John Lt.-Col. late 95th Regt.
Ward, John Ross Capt. R.N. (1*l.*)
Ward, Thos. Lett Commr. R.N. (1*l.*)
Warde, C. KH. Admiral (1*l.*)
Warde, C. A. M. Lieut. R.A. Bengal
Warde, Edw. Chas. CB. Col. R.H.A. (1*l.*)

Warde, Francis M.-Gen. R.A.
*Warden, Robert Col. 19th Regt. (1*l.*)
Wardlaw, James Maj. 2nd Roy. Lanc. Rifles
*Wardlaw, Robert Col. 1st Roy. Drags.
Waring, Walter T. Capt. Kent Art. (1*l.*)
Warlow, T. P. Capt. R.A. (1*l.*)
Warre, F. Lieut. late East Kent Militia
*Warre, Hy. J. CB. Col. 57th Regt. (1*l.*)
Warren, Charles Lieut. R.E.
Watkins, T. V. Capt. R.N.
Watson, Chas. Edward Lt.-Col. unatt. (1*l.*)
Watson, D. Col. 82nd Regt. (1*l.*)
Watson, G. L. Lieut. 1st. Life Gds. (1*l.*)
Watson, David H. Lieut. R.N. (1*l.*)
Watson, Rupert C. Capt. Ceylon Rifles
Watt, Jas. Duff late Dep. Comm. Gen.
Weatherley, F. A. Capt. 6th Inniskilling Drags. (1*l.*)
Webb, Theodosius Capt. late R.E.
Webber, Fred. W. S. Capt. (ret.) 45th Regt. (1*l.*)
Webber, George W. Lieut. R.N. (1*l.*)
Webster, G. M. MD. Surg. Staff.
Webster, Guy Lieut. late 16th Lancers (1*l.*)
Wegg-Prosser, F. R. Capt. 1st Mid. Art. Volrs. (1*l.*)
Wellesley, *Hon.* F. A. Lieut. Colds. Gds. (1*l.*)
Wellesley, G. G. CB. Rear-Adm. (1*l.*)
Wellesley, Wm. Hy. Chas. Col. late 7th Royal Fus.
Wells, James S. Commr. R.N. (1*l.*)
Wesley, *Sir* S. R. KCB. Lt.-Gen. R.L.M.I. (1*l.*)
West, C. E. late Mid. R.N. (3*l.*)
West, C. R. S. Lord, CB. Colonel (1*l.*)
West, Jas. B. Commr. R.N.
West, J. Temple Lt.-Col. late Gren. Gds.
West, *Hon.* M. S. Capt. late Gr. Gds.
Westby, A. G. Capt. 8th or King's (1*l.*)
Westby, Jocelyn T. Cornet late 2nd Drags.
Westby, J. W. Lieut. 41st Regt. (1*l.*)
Westcar, H. E. Cornet R. H. Gds. (1*l.*)
Westenra, Francis Lt.-Col. unatt. (1*l.*)
Westmacott, Spencer Col. R.E.
Westmore, Rd. Col. (ret.) 33rd Regt. (1*l.*)
Westmorland, Francis William Henry, Earl of, CB. Col. late Coldstream Guards
Westphal, *Sir* Geo. Aug. *Kt.* Admiral
Wetherall, E. R. CB. Col. Dep. Quartermaster Gen. Dublin (1*l.*)
Wetherall, *Sir* Geo. Aug. KCB. KH. Gen. Col. 84th Regt. Comg. Northern Districts (1*l.*)
Wharncliffe, E. M. G. Lord Lt.-Col. 1st W. York. Yeo. Cav. Lt. late Gr. Gds.
Wheatley, Wm. Lt.-Col. (ret.) Sco. Fus. Gds.
Wheeler, J. Ross Lt.-Col. (ret.) 29th Regt.
Wheeley, J. S. Capt. 8th or King's (1*l.*)
Wheler, *Sir* Trevor, *Bart.* Lt.-Col. late 5th Drg. Gds. (1*l.*)
Whiffen, H. W. S. Esq. Ordn. Office, Asst. Acct. General (1*l.*)
Whimper, F. A. Col. unatt. Major of the Tower of London
Whitbread, J. W. Capt. late Suffolk Art.
White, A. Lieut. Queen's Westminster Rifle Volrs. (1*l.*)
*White, C. H. Capt. and Adj. Cheshire Mil. (1*l.*)
White, Charles W. Capt. Sco. Fus. Gds.
White, Martin Admiral
White, Raym. Herbt. Lt.-Col. Sco. Fus. Gds. (1*l.*)
White, W. A. Surg. R.A. (1*l.*)
White, W. R. Lieut. 50th Regt. (1*l.*)
Whitelocke, G. F. Lt.-Col. late Ben. Army (1*l.*)
Whitfield, C. T. Surg. h.p. Ord. Med. Dep. (1*l.*)
Whitfield, Hy. Wase Col. 2nd W.I. Regt.
Whitla, Wm. Lieut. 10th Regt. (1*l.*)
Whitmore, T. C. D. Lieut. Roy. H. Gds.
Whitnall, W. B. Esq. Paym. Gen. Office
Whitshed, St. Vincent B. H. Capt. late Colds. Gds. (1*l.*)
Whitting, Reginald Capt. 8th or King's
Whittuck, S. H. P. Cornet 8th Hussars
Wickham, E. H. Lieut. Royal Art.
Wigram, Ely D. Col. late Sco. Fus. Gds. (2*l.*)
Wigram, J. R. Capt. late Colds. Gds. (1*l.*)
Wilbraham, Richd. CB. Col. unatt. Gov. of Gen. Hospl. Woolwich (1*l.*)
Wildbore, Fred. Asst.-Surg. late Colds. Gds.
Wildman, John Col. unatt. (1*l.*)
Wilkinson, B. E. Lieut. late 4th R.I.D. Gds.
Wilkinson, F. G. Col. unatt. (1*l.*)
Wilkinson, Henry G. Lt.-Col. late Sco. Fus. Gds.
Wilkinson, Thomas Lt.-Col. (ret.) Bengal Army
Willes, A. Capt. 104th Beng. Fus.
Willes, Geo. O. CB. Capt. R.N.
Williams-Bulkeley, R. M. L. Capt. R. H. Gds.
Williams, E. A. Lt.-Col. R.A.
Williams, Edw. R. Vice-Admiral (1*l.*)
Williams, H. A. Ens. 14th Regt. (1*l.*)
Williams, Jas. Edm. Insp.-General of Hospitals
Williams, Lawrance Capt. 5th W. York Mil. (1*l.*)
Williams, Lewis Duncan Maj.-Gen. (1*l.*)
Williams, Montgomery Maj.-Gen. R.E. (1*l.*)
*Williams, O. L. C. Capt. R. H. Gds.
Williams, T. P. Lt.-Col. Commt. Roy. Anglesey Lt. Inf. MP. (1*l.*)
Williams, *Sir* Wm. Fenwick, *Bart.* of Kars, KCB. Lieut.-Gen. R.A. Commanding Troops in Canada
Williams, William Surg. h.p. 99th Regt.
Williams, W. J. Rear-Adm.
Williamson, R. F. Ens. 23rd R. W. Fus.
Willis, Browne Maj.-Gen. R.A.
*Willis, W. W. G. B. Lieut. R.M.L.I. (1*l.*)
Wilmot, Eardley Major-Gen.
Wilmot, Fred. M. Eardley Col. R.A. (1*l.*)
Wilson, C. T. Lt.-Col. late Colds. Gds.
Wilson, Herbert L. Capt. late 71st Lt. Inf.

Wilson, J. J. Capt. R.E. Instr. in Fortification, Roy. Mil. Academy, Woolwich (1*l.*)
Wilson, *Sir* John Morillyon, CB. KH. Col. unatt. Major Roy. Hosp. Chelsea (1*l.*)
Wilson, R. S. Major H.M. 52nd Mad. N.I. (1*l.*)
Wilson, S. W. F. Capt. 55th Regt. Major Brigade, Malta (1*l.*)
Wilson, T. M. Maj.-Gen. h.p. 8th or King's
Wilson, W. H. Ens. 7th Royal Fusiliers
Wily, John Lieut. 18th Royal Irish (1*l.*)
Windham, Chas. Ashe, CB. Lieut.-Gen. Col. 46th Regt.
Windsor-Clive, *Hon.* G. H. W. Capt. Colds. Guards (1*l.*)
Windus, A. J. Lieut. H. M. Indian Navy (1*l.*)
Wingfield, Chas. Wm. Maj.-Gen. (ret.) R.A.
Wingfield, Digby H. R. Lieut. R. H. Gds.
Wingfield, *Hon.* M. Lieut. 1st Life Gds.
Wingfield, Fred. Dep. Asst. Com.-Gen. (1*l.*)
Winsloe, R. W. C. Capt. 21st R.N.B. Fus. (1*l.*)
Winthrop, Stephen Capt. (ret.) 22nd Regt. (1*l.*)
Wiseman, *Sir* W. S. *Bart.* Capt. R.N. (1*l.*)
Wodehouse, Edwin Col. Roy. Art. *ADC. to the Queen* (1*l.*)
Wombwell, A. Lt.-Col. late 7th Depôt Batt.
*Wood, H. Capt. Rifle Brig.
Wood, H. G. Lt.-Col. 8th or King's
Wood, James John (ret.) 15th Regt.
Wood, R. Blucher, CB. Maj.-Gen.
Wood, Thomas Lieut.-Gen.
Wood, William, CB. KH. Gen. Col. 14th Regt. (1*l.*)
Wood, William Lieut.-Col. h.p. R.M.L.I. (1*l.*)
Wood, Wm. Capt. 15th Regt. (1*l.*)
Wood, Wm. Fell Capt. 40th Middl. R. Volrs. (1*l.*)
Wood, Wm. Mark Col. Colds. Gds.
Woodall, J. W. Capt. East Rid. North. York. Art. Mil. (1*l.*)
Woodford, *Sir* John G., KCB. KCH. Maj.-Gen.
Woodgate, Francis Capt. 2nd Life Gds.
Woodhead, H. Esq. Navy Agent
Woodroffe, G. W. P. Cornet R. H. Gds. (1*l.*)
Woodward, John Capt. unatt.
*Woollcombe, R. W. Surg. Devon Art. Mil. (1*l.*)
Woolley, *Rev.* J. LLD. Insp. of Schools
Woolsey, O. B. B. Capt. Royal Art. (1*l.*)
Worsley, Francis Capt. Isle of Wight Mil. (1*l.*)
Worsley, G. F. Capt. R.A. (1*l.*)
Wray, Henry Major R.E. (1*l.*)
Wray, J. Esq. Dep.-Lieut. Lincoln
Wright, Chas. Maj.-Gen. R.E. (1*l.*)
Wright, C. J. Lt.-Col. Robin Hood's Rifle Volunteers (1*l.*)
Wright, Edward W. C. Col. 21st Dep. Batt. Chichester (1*l.*)
Wright, W. Esq. late Commissariat Dep.
Wrottesley, *Hon.* Geo. Capt. R.E. (1*l.*)
Wroughton, H. A. C. Lieut. ret. 13th L. I. (1*l.*)
Wulff, H. Powell Maj.-Gen. (ret. f.p.) R.E.
Wyatt, *Sir* Matthew Lieut. late Hon. Corps of Gent.-at-Arms (1*l.*)
Wyatt, John Surg.-Major Colds. Gds. (1*l.*)
Wygram, Godfrey J. Capt. Colds. Gds.
Wyndham, *Hon.* Henry Capt. 1st Life Gds.
Wynne, Finch C. A. Capt. Sco. Fus. Gds. (1*l.*)
Wynne, E. W. L. Lt.-Col. Gr. Gds.
Wynne, G. Col. R.E. (1*l.*)
Wynne, W. R. M. Lieut. ret. Sco. Fus. Gds. (1*l.*)
Wynyard, E. G. Col. Gr. Gds. (1*l.*)
Wyse, A. G. Capt. 48th Regt.

XIMENES, W. R. Capt. (ret.) 8th or King's (1*l.*)

YARBOROUGH, Earl of Captain late Roy. N. Lincolnshire Mil.
Yeates, W. W. Esq. late Dep. Asst. Com.-Gen.
Yeo, Gerald, MD. Surg. R.N. (1*l.*)
Yolland, Wm. Col. R.E. (1*l.*)
Yonge, Edm. Rear-Adm. (1*l.*)
*Yonge, G. N. K. A. Lt.-Col. 67th Regt. (1*l.*)
Yonge, Henry J. Capt. 61st Regt.
Yonge, W. L. Capt. R.A. (1*l.*)
Yorke, *Sir* Charles, GCB. Lieut.-General, Col. Rifle Brigade (1*l.* 10*s.*)
Yorke, F. A. Col. R.E. Insp. of Studies, 2nd Commandant Royal Mil. Academy, Woolwich (1*l.*)
Yorke, J. CB. Col. late 1st Drags. Commt. of Roy. Military Asylum, Chelsea (1*l.*)
Young, Chas. Allen Major late 33rd Regt.
Young, C. F. Major Roy. Art. (1*l.*)
Young, Thos. Major 37th Regt. (1*l.*)
Young, Wm. late Chief Com. Gen. Field Train Department, R.A. (1*l.*)
Younghusband, C. W. Col. Roy. Art.
Yule, Patrick Maj.-Gen. R.E. (1*l.*)

LIST OF LIFE MEMBERS.

ABERGAVENNY, *Rev.* J. EARL of Dep. Lt. Norfolk
Adair, H. A. Lieut. 52nd L. I. (9*l.*)
Airey, J. T. CB. Col. Colds. Gds.
Alcock, Thos. St. Leger Lt.-Col. Commt. Roy. East. Mid. Mil. (3*l.*)
Aldham, W. C. CB. Capt. R.N. (3*l.*)
Alexander, R. Maj.-Gen. Col. H.M. 24th Madr. N.I. (3*l.*)
Allen, J. L. Esq. Dep. Lieut. Perthshire
Anderson, Thomas Major 64th Regt. (1*l.*)
Andrews, Rob. A. Lt.-Col. (ret.) 30th Regt.
Archer, Clement R. Capt. late 4th Dr. Gds.
Armstrong, R. S. Maj.-Gen. R.A.
Armstrong, Thomas Maj. late 2nd W.I.R.
Arrow, W. G. Major late 28th Bomb. N.I.
Ashburnham, *Hon.* Thomas, CB. Lt.-Gen. Col. 82nd Regt.
Ashmore, Charles Maj.-Gen.
Atkinson, Thos. Ens. 1st Royals
Austin, Thomas Colonel late 69th Regt.
Aylmer, H. Major-Gen. (ret. f.p.) R.A. (3*l.*)
Aylmer, T. C. Col. unatt. (9*l.*)

BADDELEY, F. H. Major-Gen. (r. f.p.) R.E.
Bagot, Charles Colonel 3rd K. O. Stafford Militia, late Gren. Gds.
Bagot, George Capt. 69th Regt. (9*l.*)
Baldock, W. Lieut. late Rifle Brigade
*Balfour, C. James Commr. R.N.
Balfour, F. W. Major late Rifle Brig. (9*l.*)
Balfour, Geo. CB. Col. R.A. Madras (3*l.*)
Barclay, A. K. Capt. late Surrey Yeomanry
Barclay, D. W. Capt. late 90th L.I.
Baring, *Rt. Hon. Sir* Francis T. *Bart.* MP.
Barlow, Geo. Capt. 4th Duke of Lanc. Own L.I.Mil.
Barnston, R. H. Esq. Depty.-Lieut. Cheshire
Barou, R. J. Lieut.-Col. (ret.) R.E. (10*s.*)
Barrell, Justinian Capt. R.N. (10*s.*)
Barrow, W. P. Lieut. R.N. (9*l.*)
Bartley, J. Cowell Lt.-Col. 5th Fus.
Barwell, William Capt. R.N.
Basevi, J. P. Capt. R.E. Bengal (9*l.*)
Bastard, W. B. Capt. late 90th Lt. Inf. (3*l.*)
Bateman, H. W. Ens. 31st Regt. (9*l.*)
Bayfield, H. W. Vice-Admiral
Baylis, T. H. Capt. 36th Middl. Rifle Volrs. (9*l.*)
*Bayly, N. S. K. Major R.A. (3*l.*)
Bayly, John Lt.-Col. R.E. (10*s.*)
Baynes, G. Macleod Capt. h.p. R.A.
Bayntun, W. H. Capt. late 12th Roy. Lancers
Beadon, George Capt. R.N.
Beauchamp, EARL Capt. late 1st Life Gds.
Beauclerk, LORD Amelius W. Commr. R.N.
Beazley, Geo. G. Capt. 83rd Regt. (9*l.*)
Belcher, *Sir* Edward, CB. Rear-Adm.
Bell, Chas. Wm. Lieut. late 15th King's Hussars
Bell, *Sir* John, GCB. Gen. Col. 4th Reg.
Bence, H. B. Col. late Suffolk Art.
Bendyshe, J. Capt. late Camb. Mil. (3*l.*)
Bere, E. B. Major late 45th Regt.
Beresford, Wm. Hy. Capt. late Rifle Brig.
Bernard, Peter Capt. unatt.
Best, *Hon.* Thomas Vice-Admiral (3*l.*)
Beverley, Geo. EARL of Col. late N. L. I. Mil.
Bidwell, J. F.S.A. Lt. late Queen's Roy. Volrs.
Bingham, G. W. P. CB. Col. (ret.) 64th Regt.
Black, William late Mid. R.N.
Blair, William Fordyce Capt. R.N.
Blakeley, A. T. Capt. late R.A. (10*s.*)
Blanshard, Rich. Esq. late Lieut.-Gov. and Vice-Adm. of Vancouver's Island
Blundell, H. B. H. Capt. Gr. Gds. (9*l.*)
Boggis, J. E. Capt. h.p. 55th Regt. Depty. Lieut. Essex
Boileau, C. L. Major late Rifle Brigade (1*l.*)
Boileau, *Sir* J. P. *Bart.* Lieut. h.p. 90th Lt. Inf.
Bonamy, John Lt.-Col. (ret.) 6th Regt.
Borland, Oswald Commr. R.N.
*Borton, Arthur, CB. Col. 17th Dep. Batt.
Boultbee, Fred. Moore Rear-Adm.
Bourchier, Jas. J. Major (ret.) 52nd Lt. Infry. (9*l.*)
Bourne, Jas. Col. Commt. Roy. Lan. Art. (9*l.*)
Boustead, John, Esq. Army Agent (3*l.*)
Bowen, A. F. J. Lieut. R.N.
Brabazon, *Rev.* W. J. M. late Chaplain to the Forces
Brandreth, Thomas Capt. R.N. (9*l.*)
Branfill, B. A. Capt. 86th Roy. Co. Downs (9*l.*)
Breton, H. W. Lt.-Gen. Col. 56th Regt. (3*l.*)
Breton, Peter Wright Cap. Hants. Mil. (9*l.*)
Breton, W. H. Commr. R.N. (3*l.*)

Bright, R. O. Col. 19th Regt.
Brigstocke, G. C. H. P. Capt. late 4th R.I. D. Gds.
Brocas, Bernard Lieut. late 6th Dr. Gds.
Brook, G. S. Esq. Ordn. Storekeeper
Broughton, J. C. Lord, GCB. Col. R. Wilts Mil.
Brown, R. Esq. FRS. FLS. late Surgeon Scotch Fencible Regt.
Browne, H. R. Lt.-Col. 87th Roy. I. Fus. (9*l.*)
Browne, Lord John T. late Lieut. R.N.
Browne, *Rev.* R. W. Chaplain to the Forces
Browne, W. B. Ensign late 68th L. I.
Brymer, J. Capt. late 5th Dr. Gds. (3*l.*)
Buccleuch, Walter F. M. Duke of, KG. KT. FRS. Lord-Lieut. Co. Mid. Lothian
Buchan, G. W. Fordyce Col. (ret.) R. H. Gds.
Buchanan, Peter, Esq. Depty.-Lieut. Bute
Buckle, W. Hill Lieut. late 14th Regt.
Buckley, E. P. Lieut.-Gen.
Budgen, John Commr. R.N.
Buller, E. M. Major Rifle Brigade (9*l.*)
Burdett, Francis Lieut.-Col. late 17th Lanc.
Burdett, *Sir* Robert, *Bart.* Col. late 68th L. I.
Burgman, George Col. R.E.
Burrard, Sidney Lt.-Col. Gr. Gds.
Burriss, E. N. Lieut. late Ceylon Regt.
Burrows, R. E. KH. Col. late 66th Regt.
Burslem, G. J. Capt. late 94th Regt.
Burslem, N. Capt. 60th Royal Rifles (9*l.*)

CAMBRIDGE, HRH. GEORGE W. F. C. DUKE OF, KG. GCB. GCMG. Field Marshal, Commanding-in-Chief, Colonel Gren. Gds., Roy. Art. Roy. Engrs.
Caldwell, Charles B. Capt. late 66th Regt.
Caldwell, Henry, CB. Capt. R.N.
Caldwell, William Chas. Capt. late 47th Regt. (3*l.*)
Calvert, A. M. Capt. R. H. Art. (3*l.*)
Campbell, Ad. J. Lt.-Col. late 16th Regt.
Campbell, Archibald Col. late 46th Regt.
Campbell, D. L. Lieut. late 9th Roy. Lancers
Campbell, F. A. Capt. R.N. (3*l.*)
Campbell, Robert Lieut. R.N.
Cannon, Edw. St. Leger Capt. R.N.
Cannon, Frederick Commr. R.N.
Cape, Henry Surg. R. H. A. (9*l.*)
Cardigan, Jas. Thos. Earl of, KCB. Lt.-Gen. Col. 11th Hussars (3*l.*)
Carey, Le Marchant Capt. late 66th Regt.
Carey, Wm. Capt. R.A. (9*l.*)
Carmichael, Chs. M. CB. Lt.-Gen. Col. 20th Hus. (10*s.*)
Carmichael, Geo. Lynedoch Major 95th Regt.
Carpenter, C. Commr. R.N.
Castle, William Lanford Rear-Adml. (10*s.*)
Cautley, *Sir* Proby T. KCB. Col. (ret.) Bengal Art. (3*l.*)
Cavan, P. C. Lieut.-Col. late 30th Regt. (9*l.*)
Cave, Lawrence Trent Capt. late 54th Regt.
Chalmers, P. Esq. Capt. late 3rd Dr. Gds.
Chaloner, Thomas Capt. R.N. (3*l.*)
Chamberlaine, W. C. Capt. R.N. (9*l.*)
Chambers, Montague Lieut. h.p. 71st High. Light I. (9*l.*)
Chapman, J. J. Capt. h.p. R.A
Charlewood, E. P. Capt. R.N. (9*l.*)
Cheere, John Capt. R.N. (3*l.*)
Chetwode, R. Col. h.p. 3rd Dr. Gds.
Chichester, *Hon.* Aug. G. C. Lt.-Col. 77th Regt. (9*l.*)
Christie, S. Hunter, Esq. M.A. late Prof. of Math. Roy. Mil. Acad. Woolwich
Christie, W. J. Capt. late Gr. Gds.
Churchill, Lord Alfred Lieut. late 83rd Regt. M.P.
Clarke, George Calvert Col. 2nd R.N.B. Drags.
Clarke, M. de S. M'K. G. A. Capt. 50th Regt. (9*l.*)
Clavering, *Sir* William Capt. late Northumb. Mil. (3*l.*)
Clayton, Matthew Capt. Northumb. Yeo. Cav. (6*l.*)
Clery, John Capt. 100th Regt. (9*l.*)
Clinton, Fred. Col. late Gr. Gds. (3*l.*)
Clinton, H. Col. (ret.) 11th Hussars
Clinton, Hen. R. Capt. Gren. Gds. (9*l.*)
Cocks, Philip Reginald Col. late R.A. (3*l.*)
*Codrington, W. Lieut. R.N. (9*l.*)
Coffin, J. Townsend Admiral
Collett, H. Lieut. Beng. Staff Corps (9*l.*)
*Collings, J. E. Col. 33rd Regt. (9*l.*)
Colvile, Henry Lieut.-Gen.
Connop, Richard Maj.-Gen. (3*l.*)
Conroy, H. G. Col. late Gren. Gds.
Cooke, J. G. Capt. 7th Lan. Mil.
Cookes, George Capt. unatt. (3*l.*)
Cooper, D. S. Capt. late 1st Royals
Cooper, Henry Maj.-Gen.
Cooper, Leon Morse Col. unatt.
Cooper, Rob. Surg. 4th Dr. Gds.
*Coote, Robt. Capt. R.N. (3*l.*)
Corbett, William Major late 52nd Lt. Inf.
Cotton, W. Esq. Deputy-Lieut. Essex
*Cox, J. W. Col. 13th Lt. Inf. (9*l.*)
Cracroft, Peter CB. Capt. R.N. (9*l.*)
Craig, John Major Roy. N. Down Rifles (9*l.*)
Crofton, John F. Maj.-Gen. Mil. Asst. Sec. War Office
Crole, G. S. Major late 28th Regt.
Crutchley, Charles Major-General Commanding Troops Gibraltar (3*l.*)
Cunynghame, A. A. T. CB. Maj.-Gen.
Cuppage, Alex. Cornet late 4th Dr. Gds.
Cust, *Hon. Sir* E. KCH. Lieut.-Gen. Col. 16th Lancers (3*l.*)
Cust, *Hon.* P. F. Col. late 22nd Regt. (3*l.*)

D'AGUILAR, H. T. Lt.-Col. late Gren. Gds.
Dalyell, *Sir* W. C. C. *Bart.* Commr. R.N. Green. Hosp.
Dashwood, W. B. Admiral
Daubeney, H. C. B. Col. h.p. 71st High. Lt. Inf. (3*l.*)
Davis, *Sir* John F. *Bart.* KCB. Deputy-Lt. Glouc. (9*l.*)

Dawe, Charles Major late 8th or King's
Deacon, H. C. Admiral
Deane, H. C. Lieut. 17th Regt. (9*l.*)
De Bliss, Henry, *Bart.* Capt. late 4th Royal South Midd. Mil. (9*l.*)
De la Chaumette, H. L. Capt. Paymr. 97th Regt. (3*l.*)
Denison, *Sir* W. T. KCB. FRS. Col. R.E. Governor, Madras
Dennis, M. S. T. Lt.-Col. h.p. 76th Regt.
Derville, Adolphus Maj.-Gen. H.M. Madras Army
De Winton, C. L. Major 76th Regt. (9*l.*)
Dicken, H. Perry Commr. R.N.
Digby, J. A. Lieut.-Col. late Gren. Gds.
Dixon, Matthew Capt. R.N.
Dobie, Robert Surgeon R.N. (3*l.*)
Dowman, John Capt. of Invalids Royal Hospital, Chelsea
Downshire, MARQUIS of, Col. Roy. S. Down Mil.
Drake, *Sir* T. T. F. E. *Bart.* Dep. Lt. Devon, Major late 52nd Lt. Infantry
Drax, J. S. W. E. Capt. late E. Kent Mil. MP. (3*l.*)
Drummond, H. MD. late Asst.-Sur. 1st Drags. (3*l.*)
Drummond, *Hon.* Jas. Robert, CB. Rear-Admiral, Lord of the Admiralty
Dugmore, W. F. J. Capt. 8th or King's
Dundas, P. Col. late 96th Regt.
Dunlop, Hugh, CB. Capt. R.N. (3*l.*)
Duntze, J. A. Vice-Admiral
Dutton, Wm. Holmes Col. unatt.
Dyer, S. H. Capt. 8th or King's (9*l.*)

*EARLE, Wm. Lieut.-Col. Gren. Gds.
Ebury, LORD Capt. late Flint Yeomanry
Eden, A. D. Lieut. 26th Cameronians (9*l.*)
Edwards, Richard Capt. R.N.
Edwards, Sampson Lieut. R.N.
Egerton, *Hon.* A. F. Lt.-Col. late Gr. Gds.
Egmont, EARL of Admiral (3*l.*)
Ellenborough, Edward EARL of, GCB.
Ellicombe, Hugh M. Capt. R.N.
Elliot, *Sir* Charles, KCB. Vice-Admiral
Ellis, Arthur Capt. Gren. Gds. (9*l.*)
Ellis, Robert Capt. Roy. Vic. R.C. late HAC.
Elwes, R. H. H. E. Capt. late 12th Regt.
Evans, T. W. Esq. Dep. Lieut. Derby MP. (9*l.*)
Evelyn, G. P. Lt.-Col. 1st R. Surrey Mil. (3*l.*)
Everest, *Sir* Geo. CB. Col. (ret.) Bengal Army
Eversley, VISCOUNT Col. Commt. Hampshire Yeo. Cav. (10*s.*)
Ewart, C. B. Major R.E.
Ewart, David Col. (ret.) Bengal Artillery

FABER, W. Lt. late 14th Lt. Drags.
*Fanshawe, Edward Gennys Rear-Admiral
Farmer, W. R. G. Capt. (ret.) Gren. Gds.
Farquharson, F. Gen. H.M. Bomb. Army (1*l.*)
*Feilden O. B. Capt. 78th Highlanders (9*l.*)
Feilding, *Hon.* P. R. B. Lt.-Col. Colds. Gds.
Festing, E. R. Capt. R.E. (9*l.*)
*Field, R. Commr. R.N.
Fishbourne, Edm. Gardiner, CB. Capt. R.N. (3*l.*)
Fisher, E. R. Capt. (ret.) 4th R.I.D. Gds. (3*l.*)
*Fitzclarence, *Hon.* George Commr. R.N. (3*l.*)
Fitzgerald, H. C. Maj. 33rd Regt.
FitzHardinge, *Rt. Hon.* LORD M. F. F. GCB. Admiral
Fitzmayer, James W. CB. Col. R.A.
Fitzwygram, F. W. J. Col. 15th Huss.
Fletcher, E. C. Col. h.p. 3rd Drag. Gds. (3*l.*)
Flood, Warden Capt. late 51st Lt. In.
Foley, T. H. LORD, Lord-Lieut. Co. Worc. Capt. Hon. Corps Gent.-at-Arms (3*l.*)
Forbes, J. A. Lieut.-Col. late 92nd Highs.
Foster, Thos. Major-Gen. Roy. Eng. (3*l.*)
Fowke, Francis Capt. R.E. (9*l.*)
Fox, Charles Richard General (3*l.*)
Franklen, Rich. Lt. late 1st Life Gds.
Fraser, Alexander M. Lieut.-Gen.
Fraser, Chas. McKenzie Col. Ross. Mil. (3*l.*)
Fraser, W. Major-Gen. (ret.) R.A. (3*l.*)
Fraser, *Sir* Will. Aug. *Bt.* Capt. late 1st L. Gds.
Frederick, E. CB. Gen. H. M. Bomb. Army
Freeland, H. W. Esq. Dep. Lieut. Sussex (3*l.*)
Freer, J. H. Major-Gen. (ret.) R.A.
Frith, Cockayne Capt. late 38th Regt.
Frith, J. G. Esq. late Mid. R.N. (3*l.*)
*Fulford, John Capt. R.N.

GAMBIER, G. C. Admiral
Gardiner, H. L. Colonel Roy. Art.
Gardiner, J. Capt. late 6th Drag. Gds.
Garforth, W. Capt. late 3rd W. Y. Mil.
Garnham, John Commr. R.N.
Garrett, E. (b) Commr. R.N. (3*l.*)
Gascoigne-Trench, F. C. Capt. late 66th Rt. Lt.-Col. Leeds Arty. (3*l.*)
Gassiot-Sebastian, Lieut. R.N. (9*l.*)
Gaussen, F. C. Capt. Herts Mil. (3*l.*)
Gawen, J. C. G. Roberts Admiral (3*l.*)
Geddes, J. G. Lieut.-Col. unatt.
Gerard, F. Major Lanc. Hus.
Gerard, *Sir* Rob. T. *Bart.* Lt.-Col. Lanc. Hus.
Gibson, J. Brown, MD. CB. Dir. Gen. of the Army Med. Department
Gibson, R. Esq. Capt. late 28th Regt.
Gibsone, Jno. C. H. Major-Gen.
Gillum, W. J. Major unatt.
Glen, Joseph Phys.-Gen. Bomb. Army
Goddard, A. Lethbridge Capt. R. Wilts Yeo. Cav.
Godman, R. Temple Capt. 5th Drag. Gds. (9*l.*)
Godwin, John Capt. late Eng. Corps Turkish Contingent (3*l.*)
Goldie, James Capt. 17th Lancers (9*l.*)
Goodenough, James G. Capt. R.N. (3*l.*)
Gordon, J. W. Col. R. E. *ADC. to the Queen* (3*l.*)
Gordon, G. T. Capt. R.N.
Gordon, James Maj.-Gen. R.E.

Gordon, Sam. E. Col. R.A.
Gordon, Wm. Lt.-Col. late 25th Regt.
*Gore, James A. Major 71st High. L. Inf.
Gorman, W. J. Capt. late Ceylon Rifles (9*l.*)
Gosset, A. Major (ret.) R.A.
Gosset, Henry Vice-Adml. (3*l.*)
Grant, A. Capt. late 61st Regt.
Grant, John Jas. Lt.-Col. Roy. Can. Rifles
Gray, Bertie J. Lieut. late Roy. Afr. Corps
Gray, C. G. late Lieut.-Col.
Gray, R. A. late Hon. Corps of Gent.-at-Arms
Gray, *Hon.* Charles Lieut.-Gen. Col. 71st Highland. L. I. (3*l.*)
Grey, *Sir* George, KCB. Capt. late 53rd Regt. Gov. New Zealand (3*l.*)
*Grey, Ralph Wilkins Lieut.-Col. 5th Middlx. Rifle Volrs.
*Griffith, Henry Darby, CB. Col. 2nd R.N.B. Drags. *ADC. to the Queen*
Grosvenor, Earl Lt.-Col. Queen's Westminster Rifle Volrs. MP. (9*l.*)
Grover, *Rev.* H. M. late Chaplain to the Forces (3*l.*)
Gunnell, E. H. Commr. R.N. (10*s.*)
Gunter, Robert Capt. late 4th Drag. Gds.

*HAGGARD, Thos. T. Major R.A. Bombay (9*l.*)
Hall, G. B. Lt. late 19th Lt. Drags.
Hall, Henry Lieut.-Col. (ret.) Mad. Army
Hall, Marshall Lieut. Roy. East. Midd. Mil. (9*l.*)
Hall, Thos. Lt.-Col. unatt.
Hall, W. H. Lieut. R.N. (9*l.*)
Hallowell, Edw. Esq. Deputy Lt. Middlesex
Hallyburton, Lord J. F. G. GCH. Rear-Adm.
Halsey, H. W. R. W. Esq. Dep.-Lieut. Sussex (9*l.*)
Haly, Geo. T. Col. (ret.) 108th Madras Inf. (10*s.*)
Hamilton, A. P. Vice-Admiral (3*l.*)
Hamilton, *Sir* C. J. J. *Bt.* CB. Lt.-Col. late Scots. Fus. Gds. (3*l.*)
Hamilton, H. G. Capt. R.N. (3*l.*)
Hamilton, *Sir* J. J. *Bt.* Lt.-Col. late 39th Regt.
Hamilton, J. Capt. late Roy. Beng. Cav. (9*l.*)
Hand, George S. CB. Capt. R.N. (3*l.*)
Hand, Geo. Weightman Lieut. R.N. (3*l.*)
Hankey, H. A. Maj.-Gen. unatt.
Hanmer, H. KH. Col. late R. H. Gds.
Harcourt, G. S. Esq. Depty. Lieut. of Bucks
Harding, Francis Rear-Admiral
Hardinge, Edward Capt. R.N. (9*l.*)
Hardinge, Henry Lieut.-Col. (ret.) Rifle Brig.
Hardwick, J. Esq. DCL. Depty.-Lt. Tower Hamlets
Hare, H. J. Capt. 4th W. York. Mil.
Harris, J. B. Capt. late 24th Regt.
Harrison, Rev. Oct. Swale, MA. Chaplain *R.N.* (3*l.*)
Harvey, Gillmore Commr. R.N. (10*s.*)
*Harvey, Thomas Capt. R.N. (3*l.*)
Hawes, A. B. Capt. late Beng. Army
Hawkins, Ethelred Capt. late 22nd Regt.
Hawkins, F. Capt. late 89th Regt.
Hawkins, J. S. Col. R.E. (3*l.*)
*Haworth, B.B. Lt.-Col. 22nd East York Art. Volrs. (9*l.*)
Hay, James Beckford Lewis Rear-Adm.
Hay, John Baker Porter Rear-Adm.
Hay, *Sir* John C. D. *Bart.* CB. Capt. R.N. M.P. F.R.S.
Haygarth, F. Lt.-Col. (ret.) Sco. Fus. Gds.
Heaton, John R. Lt.-Col. 37th Regt. (9*l.*)
Hemery, Clem. Col. Jersey Mil.
Henderson, G. W. M. Capt. late S. F. Gds. (9*l.*)
Henry, Robt. John Capt. late 4th R. I. Dr. Gds.
Herbert, *Hon.* A. W. E. M. Lieut. (ret.) 7th Huss. (9*l.*)
Hewes, T. O. Capt. R.N.
Hibbert, F. D. Capt. R. Bucks. Yeo. late 2nd Drags.
Hilton, Thos. Capt. late 19th Regt.
*Hincks, A. S. Capt. 76th Regt. (9*l.*)
Hodge, Edw. C. CB. Major-Gen. Com. Cav. Brigade, Aldershot (3*l.*)
Holbrook, E. N. W. Lieut. Roy. Marines L. I. (9*l.*)
Holford, R. S. Capt. R. Glouc. Hussars and Depty.-Lieut. Co. Glouc. (3*l.*)
Holland, F. Commr. R.N.
Hooper, Rd. Wheeler Major (ret.) 69th Regt.
Hope, Arch. White M. Gen. (ret.) R.A. (3*l.*)
Hope, *Sir* Jas. KCB. Rear-Admiral
Hope, Wm. Lt.-Col. C.B. 71st High. Light Inf. (9*l.*)
Hore, Thos. Maj.-Gen. (ret.) R.E.
Hotham, Wm. KH. Admiral
Houstoun, Wallace Capt. R.N.
Howard, *Hon.* E. Rear-Admiral
Howorth, Rd. Lieut.-Col. (ret.) R.E.
Hulse, *Sir* Edward Lt.-Col. late S. Hants. Mil.
Humbley, Wm. Wellington Waterloo Capt. late 9th Lancers
Hussey, Wm. Hayter Capt. late 26th Regt.
Hutchinson, W. B. Clerk R.N.
*Hutton, F. Rear-Adm. (3*l.*)

INGILBY, Wm. Bates Major-Gen.
*Irving, Alex. CB. Col. R.A.

JACKSON, J. Napper Maj.-Gen. Col. 99th Regt.
James, George Maj.-Gen. (ret.) R.A.
James, W. Major late 26th Regt.
Janvrin, F. Ensign late 20th Regt.
Jarvis, *Sir* Samuel Raymond Lt.-Col. h.p. 7th Drags. Depty.-Lt. Hants (3*l.*)
Jervoise, F. J. E. Esq. Depty.-Lt. Hants (3*l.*)
Johnson, *Sir* H. A. *Bart.* Capt. late 81st Rt.
Johnson, Sir H. F. F. *Bart.* Lieut.-Col. h.p. 5th Fus.

Johnson, W. S. Lt. late 83rd Regt.
Johnston, James Lt.-Col. 8th or King's (9*l.*)
Johnston, James C. Lieut. R.N.
*Johnstone, J. Julius Capt. Gr. Gds.
Johnstone, H. Wedderburne Capt. R.N.
Jones, Hugh M. Lt.-Col. 73rd Regt. (9*l.*)
*Jones, Oliver J. Capt. R.N. (9*l.*)
Jones, R. O. Lieut. R.E. (3*l.*)
Jones, Theobald Vice-Admiral

KEANE, Edward Col. late Gren. Gds. (10*s.*)
Kell, W. G. Capt. late K.O.L.I. Mil.
Kelly, Wm. Rear-Adm.
Kennedy, R. Hartley, MD. (ret.) Surg. Bom. Army
Keppel, Fred. Chas. Lt.-Col. Gr. Gds. (3*l.*)
*Kerr, *Rt. Hon.* Lord Fred. H. Capt. R.N.
Kerr, Will. Dalrymple, MD. Surg. R.N. (3*l.*)
*Key, Astley C. CB. Capt. R.N.
Kinahan, Richard Lieut. R.N. (9*l.*)
King, Henry Capt. R.N.
King, T. H. Esq. late H.E.I.C. Serv.
Kingsmill, W. Capt. late S. Hants Militia
Kirkland, *Sir* John Army Agent
Knowles, W. Major (ret.) 50th Regt.
Knox, B. W. Lt.-Col. late Sco. Fus. Gds. Major R. Bucks Yeo. Cav.

LACON, Henry J. Capt. R.N. (3*l.*)
Lamb, Henry Lieut. HM. Indian Navy (3*l.*)
Lambert, Thomas Capt. late R.A. (10*s.*)
Larcom, Thos. Aiskew, CB. Maj.-Gen. (ret.) R.E.
Lardner, Wm. Lieut. late 2nd W. I. R.
Lardy, Christian Fred. Lt.-Col. late 53rd Regt.
Last, Edward Col. (ret. full pay), 21st R.N.B. Fus.
Lauderdale, Earl of, CB. Vice-Adm. (3*l.*)
Lawrence, J. R. Capt. late Indian Navy
Lawrence, A. Johnstone, CB. Maj.-Gen. (9*l.*)
Lawson, Robert Dep. Insp.-Gen. Hosp. (3*l.*)
*Layard, C. E. Lieut. 15th Regt. (9*l.*)
Layard, Henry L. Capt. late 97th Regt.
Lechmere, John Commr. R.N. (3*l.*)
Lecky, John G. Lt.-Col. (ret.) 38th Regt.
Lee, J. H. Lt. late South Hants Mil.
Le Mesurier F. A. Lieut. R.E. (3*l.*)
Lennox, Lord J. G. Lt.-Col. late 6th Drags.
Lennox, W. O. V.C. Lieut.-Col. R.E. (9*l.*)
Lewis, George Chas. D. Major (ret.) R.E. (3*l.*)
Lewis, Henry (a) Comm. R.N.
Ley, J. M. Col. (ret.) Madras Artillery
Liddell, *Hon. Sir* Geo. A. F. Col. (ret.) 6th Drags. (3*l.*)
Little, R. R. Capt. late Madras H. Art.
Lloyd, E. M. Lieut. R.E. (9*l.*)
Lloyd, John H. Commr. R.N.
Lloyd, Mark Capt. unatt.
Lloyd, William, MD. Surg. h.p. 36th Regt.
Loftus, Douglas Lieut. late Gren. Gds.
Long, Samuel Lieut.-Col. late Gren. Gds.
Long, Samuel Lieut. R.N. (9*l.*)
Loyd, W. K. Lt.-Col. (ret.) Madr. Art. (3*l.*)
Lucas, H. H. late H.E.I.C. Sea Service
Luce, William Commr. R.N. (10*s.*)
Lugard, *Sir* Edw. KCB. Major-Gen. Col. 31st Reg. Under Sec. of State for War (3*l.*)
Lyell, T. Lieut. R.N.

*MABERLY, Evan, CB. Col. R.A.
Macbean, Archibald Col. (ret.) R.A.
M'Call, S. Lieut. late 5th Drag. Gds.
M'Donald, Alex. MD. Surg. h.p. Ord. Med. Dept.
Macdonald, Alex. Lieut.-Col. late 68th L. I. (1*l.* 1*s.*)
Macdonald, W. Pitt Lt.-Col. H.M. 15th Madras, N. I. Paymaster-Gen. Madras
M'Donnell, Christo. Capt. h.p. 4th R.I.D. Gds.
Macdougall, A. H. Esq. Roy. Archers of the Queen's Body Guard
M'Hardy, J. B. B. Rear-Admiral
Mackenzie, Keith Stewart Lieut. late 90th Lt. Inf. (9*l.*)
Mackenzie, R. I. M. Lieut. R.A. (9*l.*)
Mackeson, E. Capt. Q. O. L. I. Mil. (9*l.*)
Mackintosh, G. D. Esq. late Hon. Corps of Gent.-at-Arms
*Mackirdy, D. E. Col. 69th Regt. (9*l.*)
*Maclean, Henry John Major Rifle Brig. (3*l.*)
Maclean, J. L. Capt. late 69th Regt.
M'Lennan, J. MD. Phys. Gen. (ret.) Bombay Army (4*l.*)
Madden, Chas. Capt. R.N. (3*l.*)
Mahon, D. Major late 98th Regt.
Mahon, H. J. Pakenham Lt. late 8th Huss.
Maitland, Fred. Thos. Col. late R. S. Corps
Malet, *Sir* A. *Bart.* Col. late Yeo. Cav. and Depty. Lieut. of Wilts
Manchester, W. D. His Grace the Duke of, Major Huntingdonshire Lt. Horse Volrs. (1*l.*)
Manners, Russel H. Vice-Admiral
Manning, C. A. Capt. late 2nd Surrey Yeomanry (10*s.*)
Mansel, J. C. Capt. late Northumb. Mil.
Margary, A. R. Major late 54th Regt. (9*l.*)
Marsh, J. C. Lory, MD. Asst. Surg. late Notts Mil. (9*l.*)
Marshall, W. Lt.-Col. late Particular Ser.
Marshall, Wm. Esq. Depty. Lieut. Cumb. MP. (9*l.*)
Martin, James Capt. late Rifle Brigade
Martin, T. Vice-Admiral (10*s.*)
Mason, Geo. Capt. late 4th Foot
Massie, Watkin Lieut. late Ind. Army (9*l.*)
Matson, Henry Major late 58th Regt.
Mayne, Dawson Capt. R.N.
Meiklam, J. Lieut. late 9th Lancers
Melville, H. Viscount, KCB. Lieut.-Gen. Col. 60th Roy. Rifles
Mercer, Saml. Capt. R.N.
Meynell, Henry Admiral
Milman, G. H. L. Lt.-Col. R.A. (3*l.*)
Mitchell, Alex. Capt. 31st Regt.

Molyneux, A. M. Capt. late 2nd Mad. Eur. Lt. Inf.
Molyneux, A. Mitchell Lieut. 23rd R. W. Fus. (3*l.*)
Molyneux, E. Lieut. 7th Drag. Gds. (3*l.*)
Molyneux, W. H. Capt. R.N.
Molyneux, H. W. Mitchell Lieut. R.N. (3*l.*)
Moncrieffe, Geo. Maj.-Gen. (3*l.*)
Moncrieffe, *Sir* T. *Bart.* Col. Roy. Perth Rifles
Montague, Willoughby Major (ret.) R.A.
Montefiore, *Sir* Moses *Bart.* FRS. Capt. late Surrey Local Mil. and Depty.-Lieut. of Kent
Montresor, Fred. Byng Capt. R.N.
Moody, Rich. Clement Col. R.E.
Moore, Cha. KW. Major late 32nd L. I. (10*s.*)
Moore, J. Capt. late 30th Regt.
Moore, T. N. Commr. R.N.
Morant, J. L. L. Lieut. R.E. (9*l.*)
Morrah, Jas. A. Capt. 60th Roy. Rifles
Morris, E. Lieut. late 54th Regt.
Mould, John A. Dep. Insp. of Hosps. R.N. (3*l.*)
Mould, Thos. Rawlings Col. R.E.
Mowbray, G. T. Capt. Leicester Mil. (9*l.*)
Moysey, H. G. Lieut. late 11th Drags.
Murchison, *Sir* Roderick Impey, KCB. FRS. &c. Capt. late 7th Lt. Drags. (10*s.*)
Murray, Alex. Capt. R.N. (3*l.*)
Murray, Dennis, MD. h.p. Staff Surg.
Murray, Freeman Major-Gen. (9*l.*)
Murray, *Hon.* Henry Ant. Capt. R.N. (10*s.*)
Murray, *Sir* Patrick Keith Capt. (ret.) Gr. Gds. (3*l.*)
Musgrave, *Sir* Georg. *Bart.* Deputy-Lieut. Cumberland and Westmoreland
Muttlebury, J. E. Major late 3rd Buffs

NORTHUMBERLAND, Algernon Percy, His Grace The Duke of, KG. FRS. FSA., &c. Admiral, President of the Institution
Napier, W. C. E. Col. Com. Staff Coll. (3*l.*)
Neele, Thos. Clarkson, Esq. late Mate R.N.
Netterville, A. J. Lieut. late 12th Regt.
Neville, Park Percy Lt.-Col. late 63rd Regt. Hon. Corps Gent.-at-Arms
Newcome, G. Capt. late 47th Regt.
Nicholl, Edward Lt.-Col. late 84th Regt.
Nicholson, J. A. Stewart Lieut. late Gr. Gds.
Nisbet, Alex. MD. Inspector General of Hospitals and Fleets
Nisbet, David, MD. Surg. (ret.) Ben. Army
Nokes, J. Major late 65th Regt.
*Nolloth, Matthew S. Capt. R.N. (3*l.*)
Nolloth, Peter B. Col. (ret. f.p.) R.M.L.I.
Noott, E. G. Staff. Asst. Surg. (9*l.*)
Northwick, Lord Col. Herefordshire Mil.
Norton, J. F. Capt. 55th Regt. (9*l.*)
Norton, R. T. L. Capt. late 2nd Life Gds.
Nugent, George Major (ret.) 2nd Drag. Gds.

O'CALLAGHAN, George W. Douglas Capt. R.N.
O'Donnell, *Sir* Charles R. Lieut.-Gen. Col. 18th Huss.
Ogilvy, Wm. Major unatt.
Oldmixon, J. Wm. Capt. R.N. (3*l.*)
Oliver, Rd. Aldworth Rear-Admiral (3*l.*)
Olpherts, Richard Capt. late 1st W. I. Rgt.
*Ommanney, Erasmus Rear-Adm. (3*l.*)
Orde, *Sir* John P. *Bart.* Depty.-Lt. Argyleshire
Ottley, E. J. Capt. Edmonton R. Rifle Regt. (3*l.*)
Otway, C. W. Esq. late Mate R.N.
Ouvry, H. A. CB. Col. unatt.

PACKE, Edmund Capt. late R. H. Gds. (3*l.*)
Packe, G. H. Lt.-Col. (ret.) 24th Regt. (10*s.*)
Pakenham, John Vice-Admiral
Pakenham, *Hon.* T. A. Capt. R.N. (3*l.*)
Papillon, Alex. Fred. Wm. Major (ret.) R.A.
Parker, J. Capt. late H.A.C.
Parkinson, C. F. Col. late 70th Regt. (3*l.*)
Parkinson, J. B. Capt. late 68th Lt. Inf.
*Parry, Charles Commr. R.N. (3*l.*)
Parry, F. John Major K.O.L. Inf. Mil.
Paschal, Geo. Fred. Lt.-Col. unatt.
Paterson, William Capt. late 60th Royal Rifles, Prof. Mil. Serv. Roy. Mil. Col. Sandhurst (3*l.*)
Patton, Robert Vice-Admiral
Paulet, Lord William, CB. Maj.-Gen. Col. 68th L.I. Comg. South Westn. Dis. (3*l.*)
Paynter, J. A. Capt. R.N. (9*l.*)
Peace, R. Commr. R.N.
Peach, H. P. K. Capt. late R. H. Gds.
Peacocke, G. J. Col. 16th Regt. (3*l.*)
Peard, Henry Cornet late 5th Dr. Gds.
Pearson, *Sir* Edwin Lieut. late of the Yeo. of the Guard
Pearson, Richard Arthur, MD. Surgeon h.p. 87th R. I. Fus.
Pedder, H. N. Capt. late 3rd R. Lanc. Mil.
Pell, *Sir* Watkin Owen, KCB. Admiral, Commissioner Green. Hosp.
Pendarves, E. W. Wynne, FRS. Lieut.-Col. late Royal Corn. Miners Lt. Inf.
Pender, Francis Henry Capt. 5th Fus. (1*l.*)
Percivall, Charles Vet. Surgeon, h.p. R.A.
Perston, David, MD. Surg. h.p. 13th Lt. Dr.
Petit, L. P. Esq. late Mid. R.N.
*Phillimore, Augustus Captain R.N. (3*l.*)
Phillipps, H. C. M. Lieut. R.N.
Pickard, A. F. Lieut. R.A. (9*l.*)
Pigot, J. H. S. Esq., FAS. Depty. Lt. Som.
*Pike, J. W. Comr. R.N. (9*l.*)
Pilkington, E. W. Capt. R.N.
Pim, Bedford Capt. R.N. (9*l.*)
Pinson, Albert Lt.-Col. 37th Madras N.I.
Piper, H. Lt.-Col. late 38th Regt.
Pitman, John C. Commr. R.N.
Poland, J. A. Commr. R.N. (9*l.*)
Pole, Arthur Cunliffe V. N. Maj.-Gen. (3*l.*)

Pollard, James P. Esq. late of the Audit Office (3*l.*)
Pollock, Fred. Lieut. (ret.) Bengal Eng.
Pollock, *Sir* Geo. GCB. KSI. Gen. Col. Commt. R.A. Bengal (2*l.*)
Ponsonby, Hy. Fred. Col. Gren. Gds. (3*l.*)
Poole, Wm. Halstead Capt. late N. Salop Yeo. Cav. h.p. R.A.
Poore, Robert Major 8th Huss. (9*l.*)
Porcher, E. A. Commr. R.N. (9*l.*)
Powell, Scott Capt. late 23rd R. W. Fus.
Powell, W. T. R. Lt.-Col. Commt. R. Cardig. Rifle Corps
Powell, W. Wellington Capt. late 86th Rgt.
Powis, Earl of Lt.-Col. Salop Yeo. Cav. (9*l.*)
Prendergast, H. N. D. Major R.E. Mad. (9*l.*)
Prescott, *Sir* H. KCB. Admiral
Preston, *Sir* Henry Lindsay, *Bart.* Capt. R.N. (3*l.*)
Preston, R. Lt.-Col. late 12th Regt.
*Prevost, James C. Capt. R.N.
Priaulx, Henry St. Geo. Capt. late K. O. Stafford Rifles
Priaulx, Jas. Col. Royal Guernsey Mil. *ADC. to the Queen*
Price, William, Esq. Army Agent
Prower, J. E. M. Capt. late 67th Regt.
Prowse, Wm. Jones Capt. R.N.

QUICK, Geo. Capt. late 1st Royal Drags.

RAMSAY, G. A. KH. Major late 77th Regt.
Ramsay, Wm. FRAS. CB. Rear-Adm. (10*s.*)
Ramsay, W. M. Major-Gen.
Ramsden, Frank Capt. R.N.
Ramsden, *Sir* John W. *Bart.* MP. Capt. W. York Art. Volunteers
Rawlinson, *Sir* Henry C. KCB. Lieut.-Col. (ret.) Bombay Army
Reed, Francis Capt. late 1st Roy. Drags.
Reynardson, Edw. Birch, CB. Col. late Gren. Gds.
Reynolds, G. S. Capt. R.N.
Rhodes, Godfrey Major unatt. (3*l.*)
Rich, G. W. T. Lt.-Col. 71st High. L.I. (9*l.*)
Richardson, Thos. Capt. h.p. 7th Huss.
Riddell, Ch. J. B. CB. Col. R.A. (3*l.*)
Robe, Fred. Holt, CB. Maj.-Gen. late 87th Roy. Irish Fus.
*Robertson, A. C. Lt.-Col. 8th or King's (3*l.*)
Robinson, Robert S. Rear-Adm. (3*l.*)
Robinson, Walter F. Commr. R.N.
Rochfort, Gustavus Cowper Col. (ret.) Madras Army
Rooper, John Capt. late Rifle Brig.
Roscow, S. Commr. R.N.
Ross, Eglintoun F. Lt. late 1st Roy. Sur. Mil.
Ross, George Capt. R.E. (3*l.*)
Rous, *Hon.* H. J. Adm.
Rowan, *Sir* William, KCB. Gen. Col. 52nd Lt. Inf.
Russell, H. R. Capt. 57th Regt. (9*l.*)
Russell, *Sir* William, *Bart.* CB. h.p. Col. 14th Hussars (3*l.*)

ST. QUINTIN, Matt. C. D. Col. late 90th Lt. Inf.
Sandilands, E. N. Major Beng. Staff Corps (9*l.*)
Sandwith, F. B. Capt. 10th Regt. (9*l.*)
*Sandys, H. Stair Lieut. R.N. (9*l.*)
Saumarez, *Hon.* J. St. Vincent Col. late 16th Lancers
Saurin, Wm. Lt.-Col. (ret.) Beng. Army
Sawbridge, S. Lieut. R.N.
Scott, Daniel MD. late Insp. Gen. Army Hosps.
Scott, George Vice-Admiral
Scott, James Rt. Capt. late 4th Dr. Gds.
Scott, John Binney Commr. R.N. (3*l.*)
Scott, W. H. H. Esq. Asst. Mil. Storekeeper (9*l.*)
Scratchley, P. H. Major R.E. (9*l.*)
Seale, F. R. Esq. FGS. late St. Helena Regt.
Seymour, *Sir* G. F. GCB. GCH. Admiral
Seymour, H. Maj. late 23rd R. Welch Fus.
Seymour, *Sir* Michael, GCB. Vice-Adm.
*Seymour, W. H. CB. Col. 2nd Dr. Gds. (10*s.*)
Shadwell, Chas. F. A. CB. Capt. R.N. (3*l.*)
Shadwell, Lawrence Col. unatt.
Sharp, H. J. Major late 86th Regt.
Sharpe, J. H. Capt. 55th Regt. (9*l.*)
Shawe, R. F. Major unatt.
Shearman, John Major late 48th Regt.
Sheffield, J. C. Capt. late 21st R.N.B. Fusiliers (9*l.*)
Shelly, J. Nicholas Surg. h.p. Greek Lt. Inf.
Sherer, Joseph, KH. Rear-Adm.
Shipley, Conway M. late Lieut. R.N.
*Shortland, Peter F. Capt. R.N. (3*l.*)
Shortland, Willoughby Lieut. R.N.
Sillery, Rob. MD. h.p. Staff Surg.
Simmons, J. Lintorn Arabin, CB. Col. R.E.
Simmons, T. C. Esq. late of the Hon. Corps of Gent.-at-Arms (3*l.*)
Simmons, T. F. Capt. late 72nd Highlandrs.
Simpson, *Sir* James, GCB. Gen. Col. 29th Regt. (1*l.*)
Sinclair, C. A. Lieut. late 56th Regt.
Skey, J. MD. late Insp. Gen. Army Hosps. (1*l.*)
Skinner, A. McG. Capt. R.N.
Smith, C. H. Esq. late of Malta Dockyard
Smith, E. H. Capt. late 76th Regt. Adj. Dorset Mil.
Smith, Henry, CB. Vice-Admiral
Smith, Horace J. Capt. South Herts Yeo. Cav. (3*l.*)
Smith, Philip Capt. Gr. Gds. (3*l.*)
Smyth, George Major late 65th Regt.
Smyth, H. C. W. Major (ret.) Bengal Army
Smyth, Rt. Carmichael Major late 36th Regt.
Smyth, William Capt. R.N.
Smyth, W. H. KFM. DCL. FRS. FSA. FRAS. &c. Admiral (3*l.*)
Somerset, *His Grace the* Duke of, KG. First Lord of Admiralty (9*l.*)

Somerset, L. E. H. Capt. R.N. (9*l.*)
Southey, J. Lowther Paym. R.N.
Sparks, Jas. Pattoun, CB. Col. I. F. O. Dublin (3*l.*)
Speer, W. D. Capt. 3rd Roy. Surrey Mil. (9*l.*)
*Spratt, Thomas A. B. CB. Capt. R.N.
Stace, Henry Coope Col. (ret.) R.A.
Stainforth, *Rev.* F. J. Capt. late Beng. Cav.
Stanley, *Rt. Hon.* LORD, MP. (9*l.*)
Stanton, Edward Lt.-Col. (ret.) Bombay Art. (3*l.*)
Stanton, Edward, CB. Col. R.E. (10*s.*)
Staveley, Wm. Col. 44th Regt.
Sterling, *Sir* Anthony Cunningham, KCB. Col. unatt. (3*l.*)
Steward, Hen. Holden Capt. 2nd Dr. Gds. (3*l.*)
Stewart, Alex. Esq. Ordnance Storekeeper
Stewart, Alex. Esq. Depty. Lieut. Norfolk
Stewart, John Campbell Capt. 72nd Highs. (9*l.*)
Stewart, Rich. H. Esq. War Office
*Stewart, W. Little Lt.-Col. 2nd Dep. Batt. Chatham
Stilwell, John Gillian, Esq. Navy Agent (3*l.*)
Stilwell, Thomas, Esq. Navy Agent
*Stirling, Chas. Capt. R.N. (9*l.*)
Stirling, M. Esq. Royal Archers of Scotland
Stopford, Rt. Fanshawe Rear-Adm.
Stotherd, Rich. Hugh Capt. R.E. (3*l.*)
Stuart, Donald Major late 46th Legt.
Stuart, Herbert Crichton, Esq. Depty. Lieut. Bute
Stuart, Wm. Esq. Depty. Lieut. Bedford
*Stubbs, F. W. Capt. Roy. Horse Art. Beng. (9*l.*)
Stucley, W. L. Lt.-Col. Gren. Gds.
Sudeley, S. C. G. LORD Capt. (ret.) Gr. Gds.
Sulivan, Bartholomew J. CB. Rear-Adm. (3*l.*)
Sulivan, Thos. Ross Capt. R.N. (3*l.*)
Sullivan, H. Col. late 6th Regt.
Sweney, Eugene, Esq. Admiralty (3*l.*)
Symonds, T. P. Lt.-Col. Hereford Mil.
Symonds, T. G. Lieut. late 4th Dr. Gds.
Synge, Millington Hy. Lieut.-Col. R.E.

TALBOT, *Sir* Charles, KCB. Vice-Adm. (10*s.*)
Tanner, J. N. Lieut. 82nd Regt. (9*l.*)
Tapp, Thos. CB. Col. 103rd Royal Bombay Fus. *ADC. to the Queen*
Tarleton, J. W. CB. Capt. R.N. (3*l.*) *ADC. to the Queen*
Taylor, C. S. S. Capt. R.H.A. (9*l.*)
Taylor, Pringle, KH. Lieut.-Gen. Col. 24th Regt.
Taylor, Wilbraham Capt. 6th Batt. Middl. Rifle Volrs. (9*l.*)
Teale, Chas. Shipley Col. (ret. full pay)
Tenison, Edward Capt. late 14th Drags.
Thackwell, Jos. Edwin Lt.-Col. unatt. Asst. Adj. Gen. Portsmouth
Thompson, T. Perronet Lt.-Gen.
Thompson, C. W. Col. 7th Dr. Gds. (9*l.*)
Thomson, E. R. Lieut. late 14th Drags.
Thresher, Wm. Lieut. R.N. (9*l.*)
Tighe, Jas. Lowrie Surg. h.p. 12th Roy. Lanc.
Timbrell, T. CB. Lieut.-Col. (ret.) Bengal Army (10*s.*)
Tinling, E. B. Rear-Adm.
Todd, James Henry Maj. P.W.O. Donegal Militia
Tomkyns, *Rev.* John Capt. late Royal Drags.
*Torrens, H. D. Lieut.-Col. 23rd R. Welch Fus.
Townley, George Lieut. late Rifle Brig.
Trafford, H. T. Capt. 43rd Lt. Inf. (9*l.*)
Tryon, Robert Capt. R.N.
Tubbs, Robert, Esq. Depty. Lieut. Middlesex
Tupper, A. C. Capt. late Royal Brecknockshire Rifle Regt. (3*l.*)
Tupper, D. W. Major 50th Regt. (9*l.*)
Turner, F. H. Col. late Gren. Gds.
Turner, William Rear-Adm.
Turnor, Christopher Hatton Lieut. Rifle Brigade (9*l.*)
Tweeddale, George, MARQUIS of, KT. KCB. Gen. Col. 2nd Life Gds. (3*l.*)
Tylden, *Sir* J. Maxwell Lt.-Col. late 52nd L. I.
Tyler, *Sir* James Lieut. late of the Hon. Corps Gent.-at-Arms (3*l.*)
Tyler, H. W. Capt. R.E. (3*l.*)
Tytler, Wm. Fraser Capt. late 9th Bengal Light Cavalry (9*l.*)

VALIANT, Thos. Jas. Maj.-Gen.
Vandeleur, John Col. late 10th Hussars
Verling, Jas. MD. Insp. Gen. h.p. Ord. Med. Dept.
*Verney, E. Hope Commr. R.N. (9*l.*)
Vernon, LORD Geo. J. W. Major Derbyshire Rifle Volrs, (9*l.*)
Vernon, *Hon.* A. H. Capt. Commt. 2nd Corps Derbyshire Rifle Vols. (9*l.*)
Vernon, W. F. Capt. late 68th Regt. (3*l.*)
Vivian, Hussey Lt.-Col. 4th Swansea Rifle Volrs. MP. (9*l.*)
Vivian, *Sir* Robt. J. H. Lieut. Gen. H. M. I. Forces
Vyvyan, Rich. H. S. Lt. late Duke of Cornwall's Rangers.

WALES, HRH. THE PRINCE OF, KG. KSI. Gen. Col. 10th Hussars (9*l.*)
Waddilove, C. L. Capt. R.N. (3*l.*)
Wake, Baldwin A. Commr. R.N.
Walker, A. L. Lieut. 99th Regt. (9*l.*)
Walker, *Sir* Baldwin, W. *Bart.* KCB. Rear-Admiral
Walker, C. F. Lieut. R.N. (3*l.*)
Walker, E. W. Forester, CB. Maj.-Gen.
Wallis, *Sir* P. W. P. KCB. Admiral
Walpole, *Sir* Rob. KCB. Maj.-Gen. (9*l.*)
Walter, E. Capt. late 8th Hussars (3*l.*)
Ward, F. B. Lieut.-Col. (ret. h.p.) R.A. (10*s.*)
Ward, James H. Capt. R.N.
Ward, Will. Cuthbert Lieut.-Gen. Col.-Commandant R.E.
Ward, W. R. Capt. (late) South Down Mil.

Warden, Fred. CB. Rear-Adm.
Warren, Wm. CB. Rear-Adm. (3*l.*)
Warry, E. T. Lieut. R.A. (9*l.*)
Waters, Marcus Antonius Major-Gen. R.E.
Watkins, Westrop Major-General, Col. H.M. 48th Madras N.I. (3*l.*)
Watling, John Wyat Vice-Admiral
Watts, J. J. Capt. late Cumb. & Westmoreland Yeo. Huss.
Webb, *Sir* Henry Capt. late Life Gds.
Webb, J. M. Capt. late 4th R. Irish Drag. Gds.
Webster, *Sir* Augustus F. *Bart.* Lieut. R.N.
Welch, J. W. Capt. late Hon. Art. Comp. (3*l.*)
Weller, T. M. M. Capt. W. Kent. Mil.
Wellesley, *Hon.* William Capt. late R.N.
Wellington, Arthur DUKE of, KG. Lieut.-Gen. Col. Comdt. Vict. Rifle Volrs.
Wemyss, David Douglas Capt. late 48th Regt. and Royal Montg. Rifles
Wemyss, W. B. Lt.-Col. late 1st Beng. Cav. (9*l.*)
West, *Hon.* W. E. S. Capt. Gr. Gds. (3*l.*)
Western, Jas. Roger Col. late Beng. Eng. (3*l.*)
Wheatley, John Capt. R.N. (3*l.*)
Whichcote, George Maj.-Gen. unatt.
Whinyates, *Sir* Edw. Chas. KCB. KH. Lt.-Gen. Col.-Commt. R.A.
Whish, Claudius B. Lieut. late 14th Huss. (3*l.*)
Whitbread, W. H. Esq. Deputy-Lieut. Bedford
White, Loraine Major unatt. Barrack Master, London (3*l.*)
Whitter, J. R. Esq. late Asst. Paym.-Gen.
Whittingham, Ferdinand, CB. Col. unatt.
Wightman, George Lt.-Col. late 67th Regt.
Wilkinson, Chas. Edmund Col. R.E.
Williams, T. B. Capt. late 4th R.I. Dr. Gds.
Williamson, J. Esq. late R.N.
Willink, W. N. Mid. R.N. (9*l.*)
Wilmot, Chas. Edward Capt. R.N.
Wilson, George Lt.-Col. late 65th Regt.
Wilson, John P. Lieut. 1st Warwick Mil. (9*l.*)
Wilson, Lestock P. Esq. Lieut. late Westm. Volunteers (9*l.*)
Wilson, Thomas Capt. R.N. (10*s.*)
Wilson, *Sir* T. M. *Bart.* Col. W. Kent Mil. (3*l.*)
Wilton, T. EARL of, GCH. Col. Q.O.L.I. Mil.
Winchester, MARQUIS of Col. Hants Mil.
Winter, Chas. Capt. late 66th Regt.
Winterton, E. EARL of Capt. Commt. 6th Sussex Rifle Volrs. (3*l.*)
Witt, Geo. E. Esq. FRS.
Wood, *Rt. Hon. Sir* Charles, *Bart.* GCB. Secretary of State for India
Wood, Jas. Capt. h.p. R.M. L. I.
Woodall, John, Esq. Deputy-Lt. Yorkshire (10*s.*)
Woodford, *Sir* Alexander, GCB. GCMG. Gen. Col. Sco. Fus. Gds. Lieut.-Gov. Chelsea Hospital
Woodgate, Thomas Commr. R.N.
Woodgate, William Lieut. late 25th Regt.
Wrey, W. Long Lieut. late Newf. Corps.
Wright, Chas. Jas. Col. R.A.
Wright, S. Capt. late 3rd Buffs.
Wroughton, J. W. Lt.-Col. late Colds. Gds.
Wyatt, S. Capt. h.p. R.A. (3*l.*)
Wylde, Wm. CB. Lieut.-Gen. Col.-Commt. R.A. (3*l.*)

YALE, W. Parry, CB. Lt.-Col. late 32nd L. I.
Yelverton, Hastings R. CB. Rear-Adm. Second in command Mediterranean
Yorke, Philip Jas. FRS. Col. late Sco. Fus. Gds. (3*l.*)
Yorke, Reginald Capt. R.N.
Young, Allen W. Lieut. R.N.R. (9*l.*)
Young, Horatio B. Capt. R.N.
Young, Jas. Robt. Major-General (10*s.*)
Young, W. L. M. CB. Superintend. of Stores (3*l.*)
Yule, Jas. Commr. R.N. (3*l.*

HONORARY MEMBERS.

BYE-LAWS.—SECTION X.

His Majesty the KING of the NETHERLANDS.
His Royal Highness Prince Alexander of the Netherlands.
His Royal Highness the Count de Paris.

The Hon. Lady Grey.
Mrs. Smyth.
Lady Grey.
Mrs. Egerton Hubbard.
Mrs. Alexander.
Mrs. Jackson.

Lady Mulcaster.
Mrs. Somerville.
Miss Mary Somerville.
Miss Martha Somerville.
Lady Emily Ponsonby.

Lady Gomm.
Lady Taylor.
Mrs. Hayes.
Miss Roberts.
Lady Franklin.

Addams, Robert, Esq.
Anderson, John, Esq. Assistant Superintendent Royal Gun Factories, Woolwich.
Arrow, Fred. Captain
Baldock, William, Jun. Esq.
Behnes, William, Esq.
Bentham, George, Esq. FRS. LS. and HS.
Bentley, Richard, Esq.
Bourne, John, Esq. CE.
Broderip, W. J., FRS.
Brooke, *Sir* James, KCB. Rajah of Sarawak.
Casher, E. Esq.
Close, Mark C. Captain
De la Chaumette, F. T. Esq.
Downes, Edward, Esq.
Drummond, A. Mortimer, Esq.
Drummond, A. Robert, Esq.
Drummond, Charles, Esq.
Drummond, George, Esq.
Drummond, John, Esq.
Fairbairn, W. Esq., LLD. &c.
Fergusson, James, Esq. FRAS.
Filose, Capt. Scindia's Service
Galton, Fran. Esq. MA. FRS. FRGS.
Gordon, A. F. Esq.
Gould, John, Esq. FRS. &c. &c.
Grey, *Right Hon. Sir* George, *Bt.* GCB. MP.
Hardwick, Philip, Esq. FRS.
Harris, *Sir* William Snow, FRS.
Haverfield, *Rev.* T. T. BD.
Henslowe, Professor.
Hope, *Rev.* F. W.
Jones, Owen, Esq.
Laird, John, Esq. M.P.
Laurence, *Rt. Hon. Sir* J. *Bart.* GCB. KSI. PC., Viceroy and Governor-General of India.
Lee, J. Esq. LLD. FRS. FRAS. &c.
Mallett, R. Esq. CE. FRS. &c.
O'Byrne, W. R. Esq. Author of "Naval Biography."
Oliphant, Laurence, Esq. FRGS.
Pettigrew, W. V. Esq. M.D. &c.
Sandwith, Humphrey, Esq. MD. CB. DCL.
Sedgwick, Professor, FRS. &c.
Smyth, C. Piazzi, Esq. Astro. Roy. for Scotland
Smyth, W. Warrington, Esq. FRS.
Stephens, Andr. John, Esq. FRS. Standing Counsel to the Institution.
Taylor, G. L. Esq. Architect of the Institution.
Tobin, Geo. Webb, Esq.
Whewell, Professor, FRS. FRAS.
Wigram, Clifford, Esq.
Wyatt, James, Esq.

CORPS DIPLOMATIQUE.

Austria.—Apponyi, Count, Ambassador Extraordinary and Plenipotentiary.
Bavaria.—Cetto, Baron de, Envoy Extraordinary and Minister Plenipotentiary.
Belgium.—Van de Weyer, M. Sylvain, Envoy Extraordinary and Minister Plenipotentiary.
Denmark.—Bille, M. Torben de, Envoy Extraordinary and Minister Plenipotentiary.
Italy.—Azeglio, Marquis E. d', Envoy Extraordinary and Minister Plenipotentiary; Maffei, Count, First Secretary.
Netherlands.—Bentinck, Baron, Envoy Extraordinary and Minister Plenipotentiary.
Portugal.—Lavradio, Count de, Envoy Extraordinary and Minister Plenipotentiary.
Prussia.—Benstorff, Count Von, Ambassador Extraordinary and Minister Plenipotentiary.
Russia.—Brunnow, Baron de, Ambassador Extraordinary and Plenipotentiary.
Sweden and Norway.—Wachtmeister, Count C., Envoy Extraordinary and Minister Plenipotentiary.
Beckfrüs, Baron, Secretary of Legation.
Turkey.—Mursurus, Bey, M., Ambassador Extraordinary and Plenipotentiary.
United States of America.—Adams, C. F. Esq., Envoy Extraordinary and Minister Plen.

FOREIGN OFFICERS.

Bode, Baron de, Major-Gen. Imp. Russ. Ser.
Cecille, Admiral, French Navy.
Da Cunha, A. P. Capt. Port. Navy.
Graham, J. D. Major, U.S. Topograph. Eng.
Lampo, A. Cavaliere, Capt. Italian Navy.
Lendy, Capt. A. F. late of the French Staff.
Maury, Capt. late United States Navy.
Pirche, Colonel, the Baron de, French Army.
Tchitchagoff, Admiral, Imp. Russian Navy.
Todleben, Lieut.-General E. de, Imp. Russian Service.
Usedom, Baron Von.

CORRESPONDING MEMBER.

Novitzky, N. de, Lieut.-Col. Imp. Russ. Service.

Replaced with Commercial Microform

1993